St. Louis TMIP Model Review

East-West Gateway Council of Governments

December 7, 2006

EAST-WEST GATEWAY
Council of Governments
Creating Solutions Across Jurisdictional Boundaries

Purpose of the Meeting

- TMIP Peer Review
- Panelists

  Chandra Bhat — UT

  David Boyce — Prof. Emeritus UIC

  Frank Spielberg—VHB

  Guy Rousseau — ARC

  Ken Cervenka — NCTCOG (Chair)

Intended Model Uses

- Satisfy Federal Mandates
- Transportation Improvement Plan (TIP)
- Long Range Plan
- Air Quality Analysis
- Motor Vehicle Emission Budget -SIP Budget
- Corridor Analysis and Sub-area Studies
- Impact of Transit Alternatives
- Toll and HOV Lanes Analysis

Agenda for Today

- 8:45 AM Introduction
- 9:00 AM Purpose of the Meeting
- 9:15 AM Introduction & Background
- 9:30 AM Land Use & Demographic Forecasting
- 9:45 AM Household Interview Survey
- 10:00 AM Transportation Network Development

- 10:30 AM BREAK

- 10:45 AM Big Picture Issues: Validation

- 12:00 PM Lunch

- 1:00 PM Model Structure and Description
- 5:00 PM Adjourn

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Agenda for 8th December

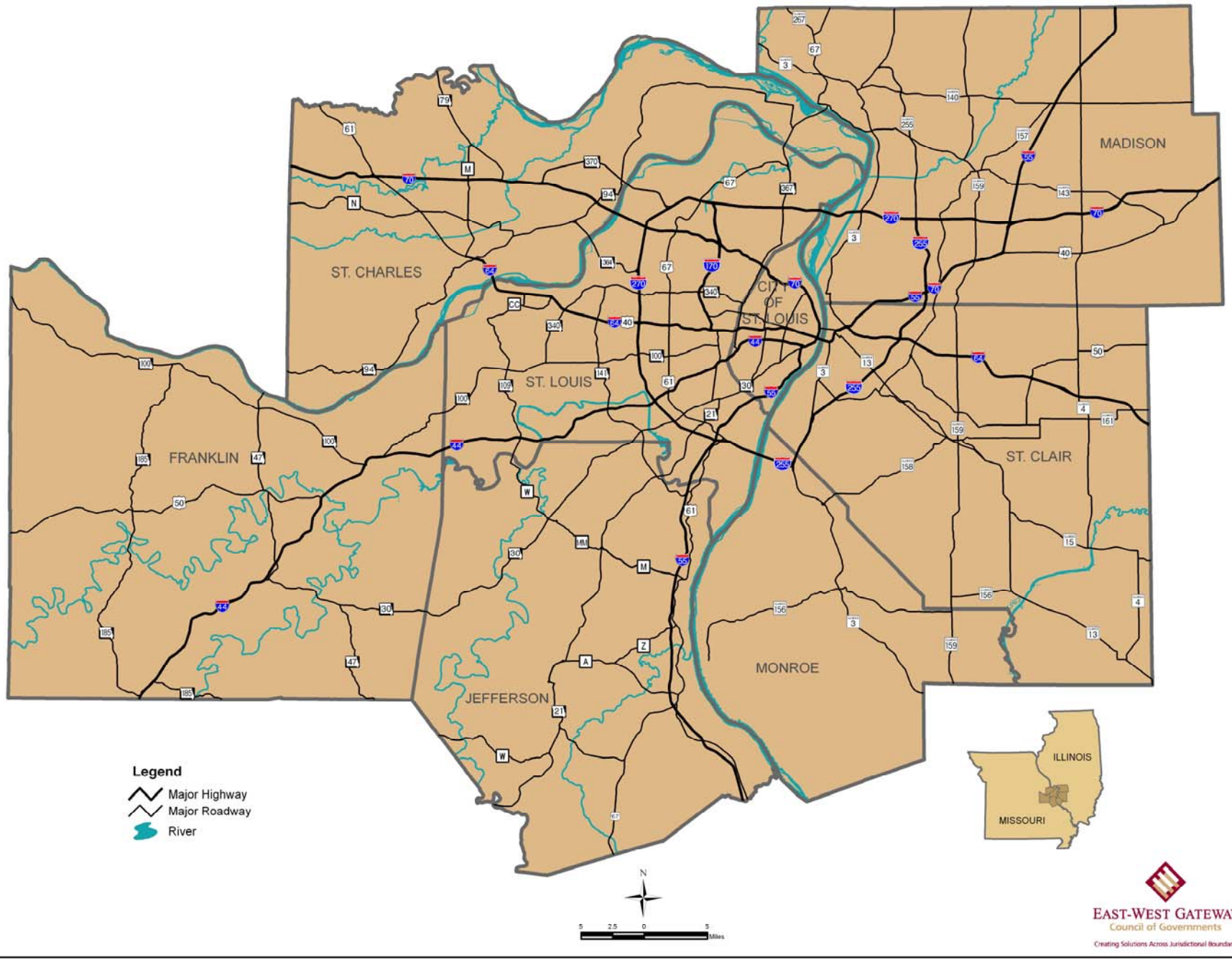
- 8:15 AM Continental Breakfast
- 8:45 AM Follow-up on Model Discussion
- 10:00 AM Closed Door Panel Discussion

- 12:00 PM Lunch

- 1:00 PM Panel Recommendations and Open Discussion

- 3:00 PM Adjourn

East-West Gateway -- Planning Area



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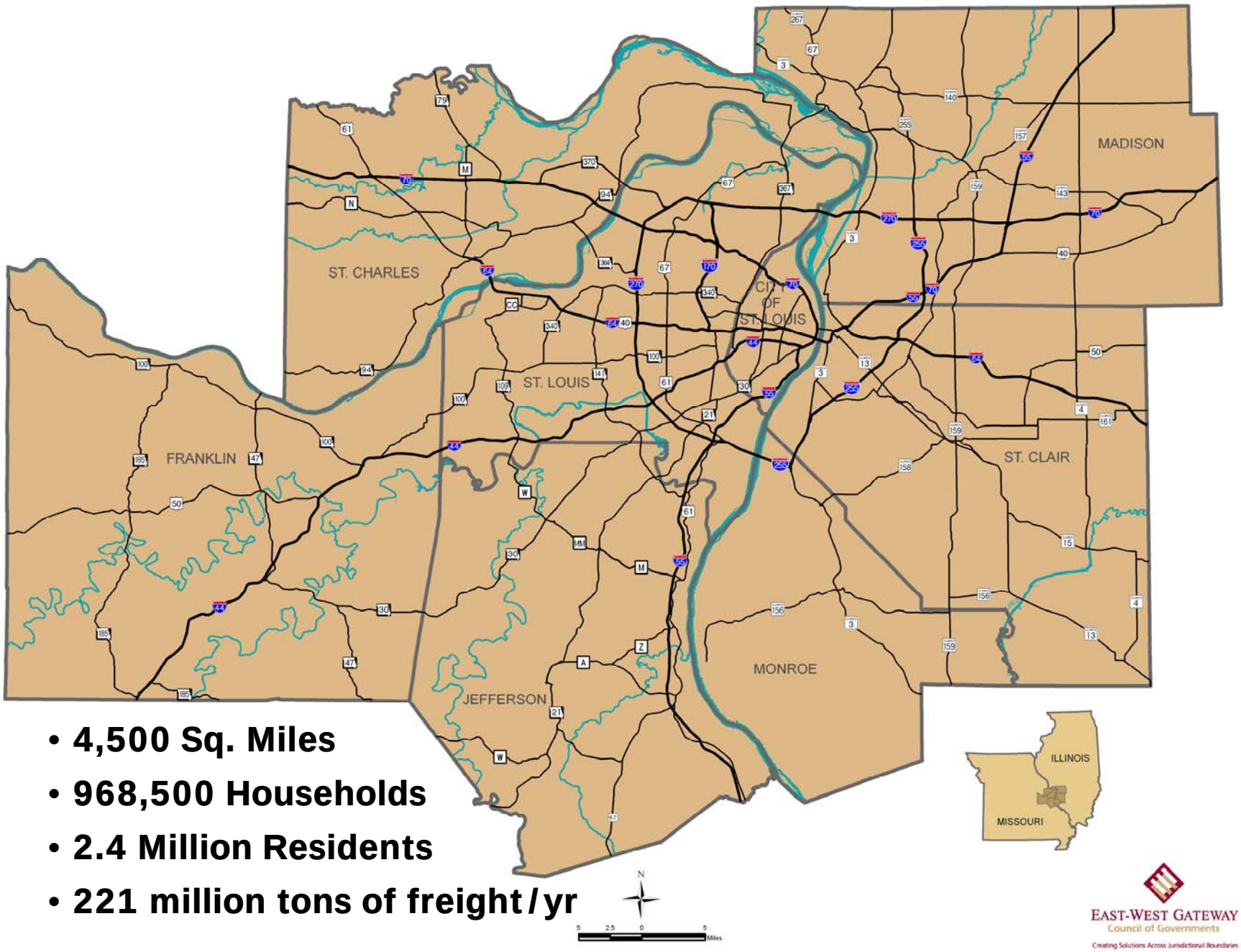
East-West Gateway -- Planning Area



- 4,500 Sq. Miles
- 968,500 Households
- 2.4 Million Residents
- 221 million tons of freight/yr

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Some Statistics

- 3.89 trips per capita
- 2.51 person per HH
- 1.22 workers per HH
- 1.69 vehicles per HH
- 8.59 vehicle trips per HH
- 9.76 person trips per HH
- Mean Trip Duration: 17.87 minutes
- Mean Work Trip Duration: 22.57 minutes
- 18,514 Roadway Miles
- 21.58 Daily Vehicle Miles Traveled per capita

Source: NuStats

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Comparative Metro Areas

	St. Louis (EWGCC)	Anchorage (AMATS)	Philadelphia (DVRPC)	Knoxville (KUA MPO)	Columbus (MORPC)
Total Persons	2,482,935	260,283	6,188,463	687,249	1,540,157
Total Households	968,533	95,080	2,321,679	281,514	610,895
Year of Survey	2002	2002	2000	2000	1999
Household Size	2.5	2.6	2.4	2.4	2.5
Household Vehicles	1.7	2.0	1.6	1.8	1.7
Person Trip Rate	3.89	4.1	3.5	3.8	3.8
Household Trip Rate	9.8	10.3	8.1	8.2	9.5

Source: NuStats

Existing Model

- Existing Model Developed in Early 1980, in MINUTP
- 1,066 and 43 External Stations
- Small Sample Survey—1990
- Revalidated—1997
- Cube Application Manager—2003

Background

- SAFETY-LU Legislative Changes, USEPA
- Model Improvement Plan
- 2002 HIS NuStats
- 2002 On-Board Passenger Survey
- Census Data

Background

- 2003 RFP
- Dec 2003 PB Consult Awarded Contract
- Jan 2004 Start Date
- PB Model Development on-going for Three Years
- TMIP Model Validation and Reasonableness Checking Manual

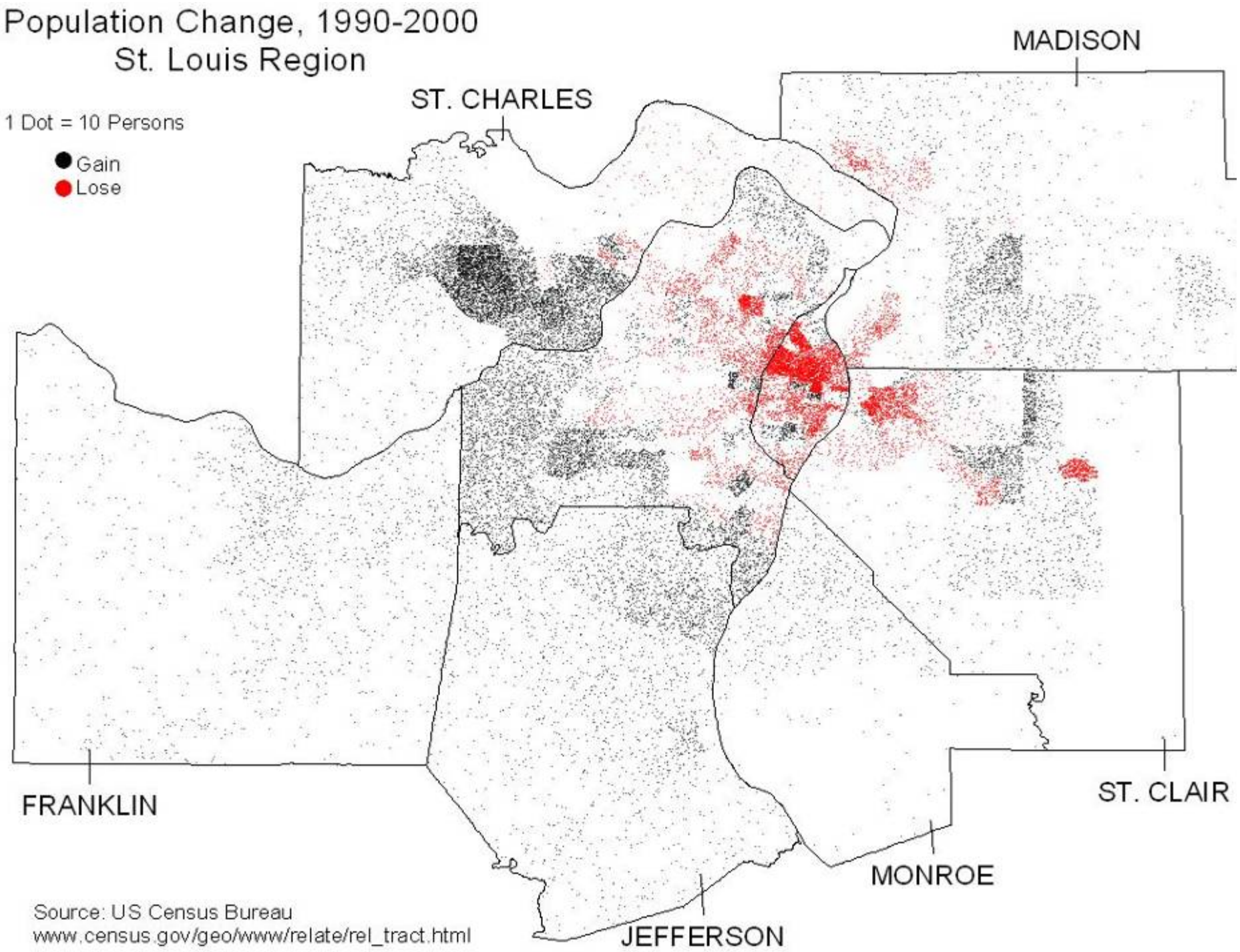
- Model is Still Not Validated

Charge to the Panelists

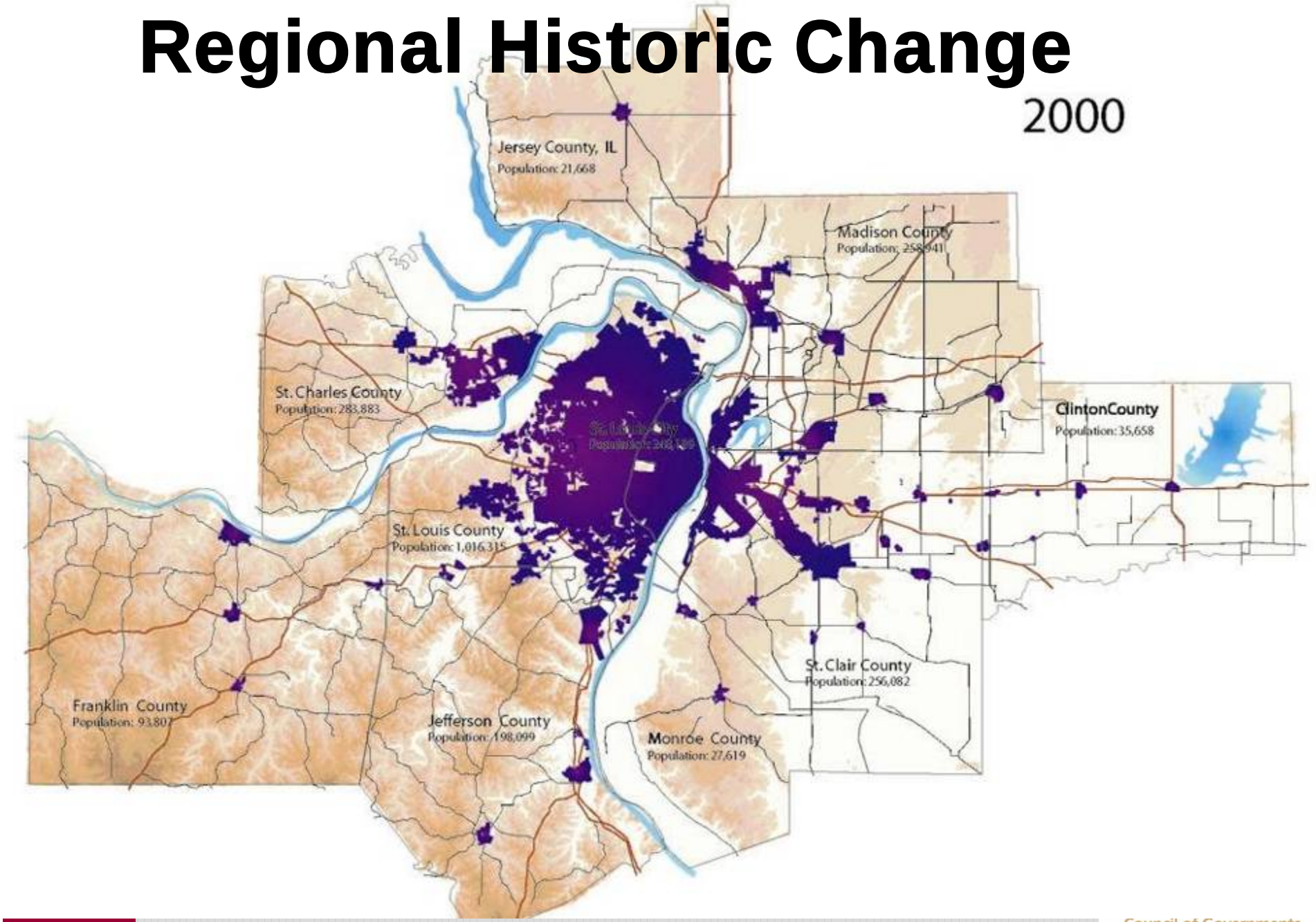
- Comment on the Sufficiency of the Model
- Identify Probable Causes of Problems and Potential Solutions
- Comment on Use of K-Factors
- Enhancements – Short and Long Term

Topics

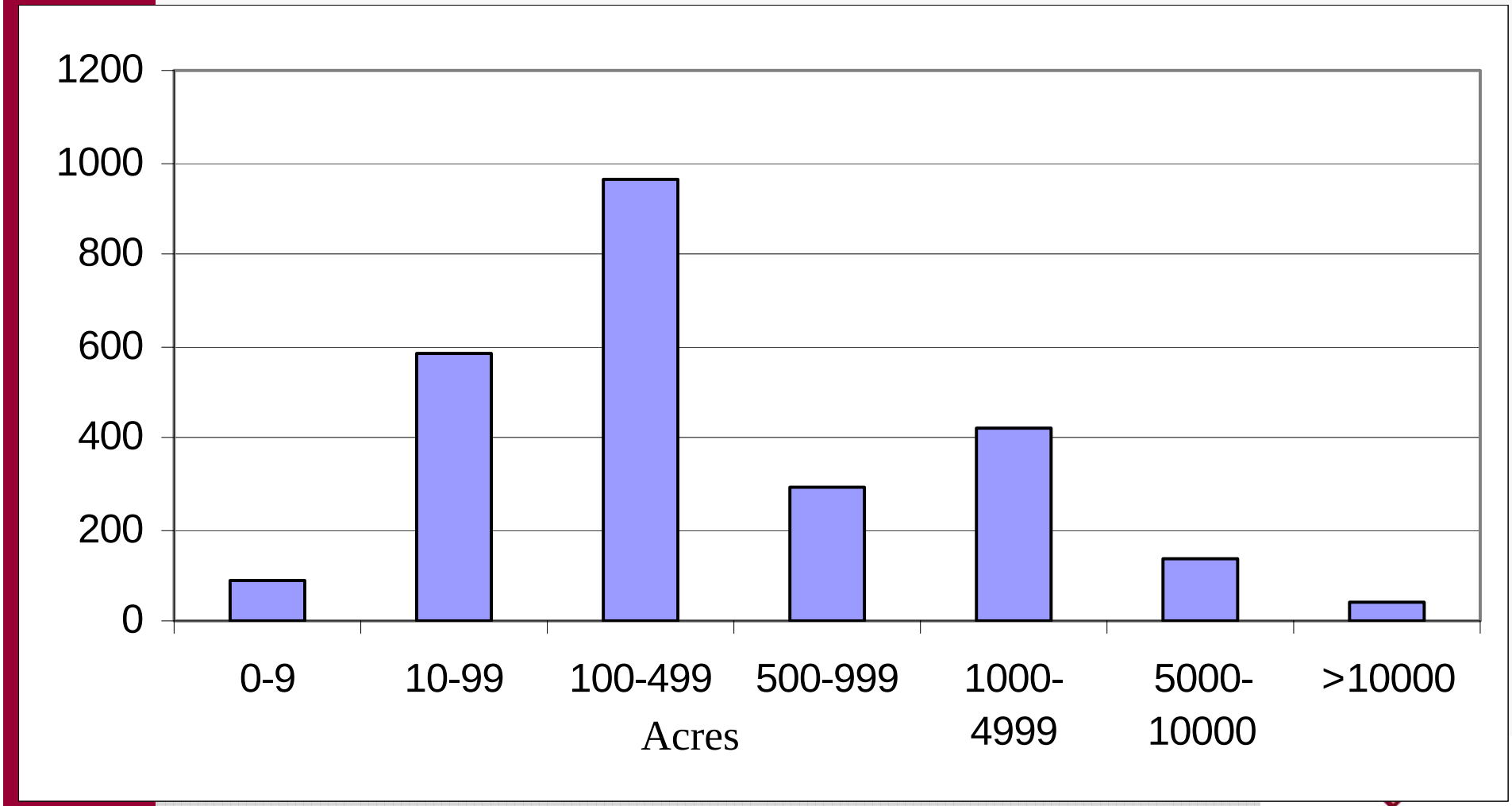
- The Region: Geography and Trends
- Land Use Allocation Model (LUAM)
- LUAM Forecasts
- Future Direction: Gateway Blueprint Model


Population Change, 1990-2000
St. Louis Region
1 Dot = 10 Persons
Gain
Lose
MADISON
ST. CHARLES
FRANKLIN
ST. CLAIR
MONROE
JEFFERSON
Source: US Census Bureau
www.census.gov/geo/www/relate/rel_tract.html

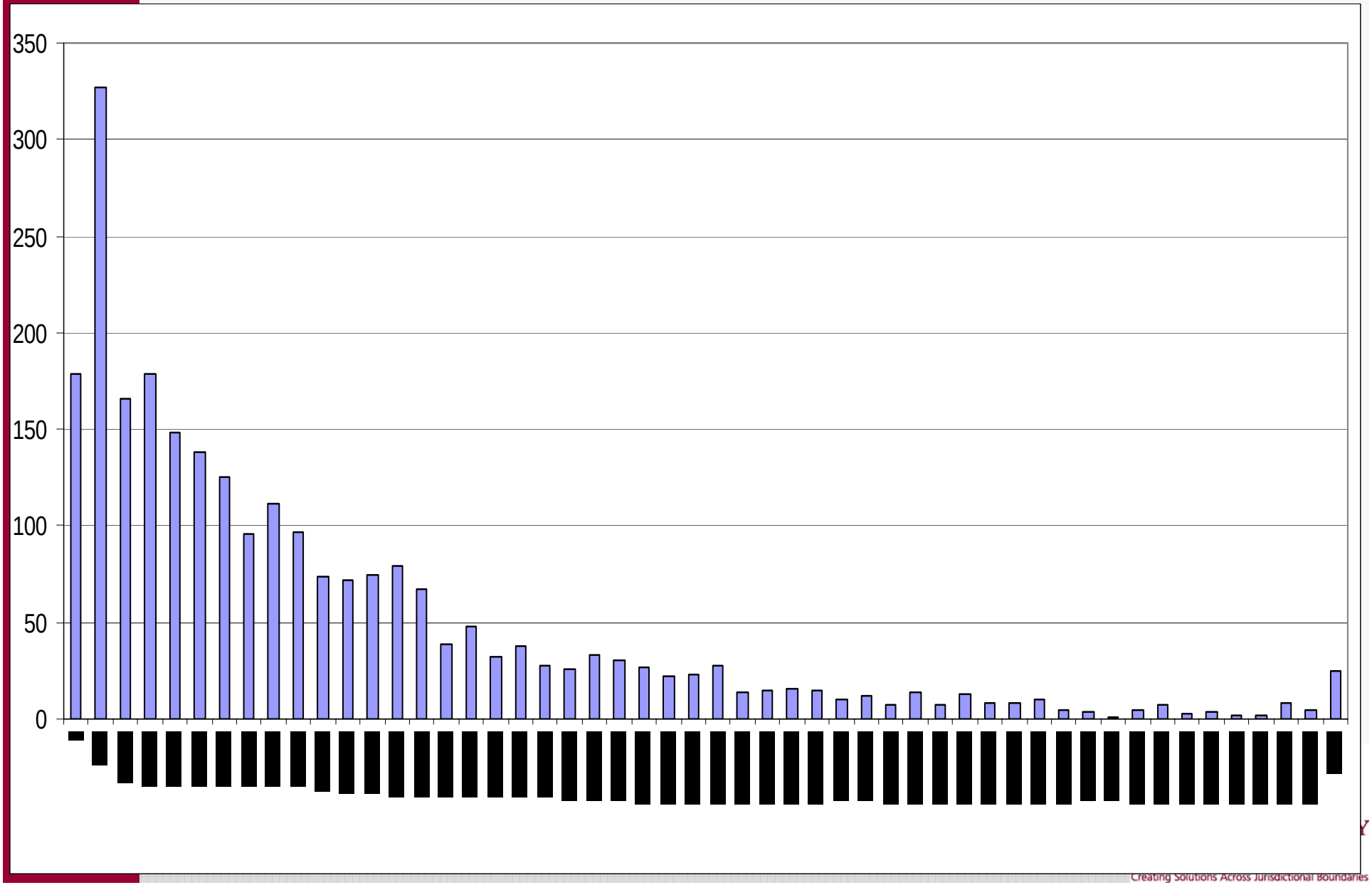
Regional Historic Change



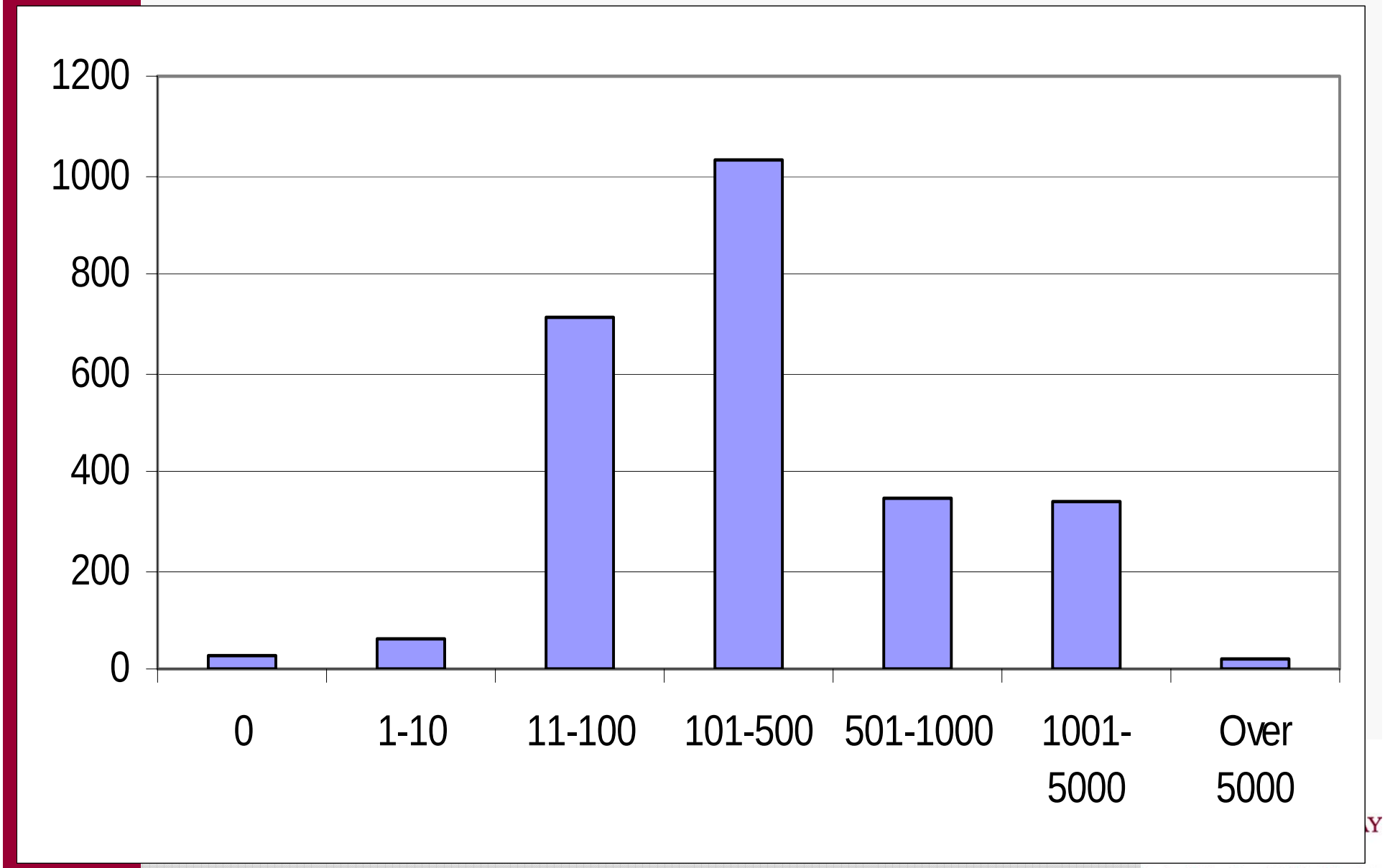
TAZ Acreage: Frequency Distribution



TAZ 2000 Population Frequency Distribution



TAZ 2000 Employment Frequency Distribution



Land Use Allocation Model (LUAM)

Step 1: County-Level Forecasts

- Cohort Survival Model-No Migration
- Adjust based on
  - Expert Surveys
  - Current Development Plans
- This yields “control totals” for each county

LUAM: County Level Forecasts

	2000	2002	2005	2010	2015	2020	2025	2030	2035
St. Louis City	348,189	339,473	326,400	310,000	314,500	317,400	323,100	327,400	331,500
St. Louis County	1,016,315	1,017,029	1,018,100	1,021,800	1,020,900	1,016,200	1,008,700	1,004,200	999,700
St. Charles County	283,883	296,090	314,400	344,700	364,800	385,000	397,200	408,000	421,900
Jefferson County	198,099	202,859	210,000	224,700	233,600	245,400	255,500	263,800	272,100
Franklin County	93,807	95,764	98,700	106,900	116,800	125,500	135,000	144,400	15,400
Missouri Subtotal	1,940,293	1,951,216	1,967,600	2,008,100	2,050,600	2,089,500	2,119,500	2,147,800	2,040,600
Madison County	258,941	261,325	264,900	271,500	278,600	285,900	293,100	300,300	307,500
St. Clair County	256,082	257,689	260,100	265,800	270,600	274,300	279,600	284,100	288,600
Monroe County	27,619	28,611	30,100	32,400	34,200	35,500	36,900	38,300	39,700
Illinois Subtotal	542,642	547,625	555,100	569,700	283,400	595,700	609,600	622,700	635,800
Region	2,482,935	2,498,841	2,522,700	2,577,800	2,634,000	2,685,200	2,729,100	2,770,500	2,676,400

Land Use Allocation Model
Step 2: Attractiveness Scores

Development attractiveness is a function of:

- Developable Land
- Proximity to "Attractors," e.g:
  - Interstate Ramps
  - Major Intersections
  - Employment Centers
  - Cultural Centers

Land Use Allocation Model
Step 3: Allocation

- Account for known development activity
  - Geocode ongoing projects by TAZ
  - Subtract expected development from control totals
- Allocate adjusted control totals using attractiveness scores
- Assume current residential/commercial density to avoid exceeding amount of developable land
- This yields population forecasts by TAZ

A Note on Employment Forecasts

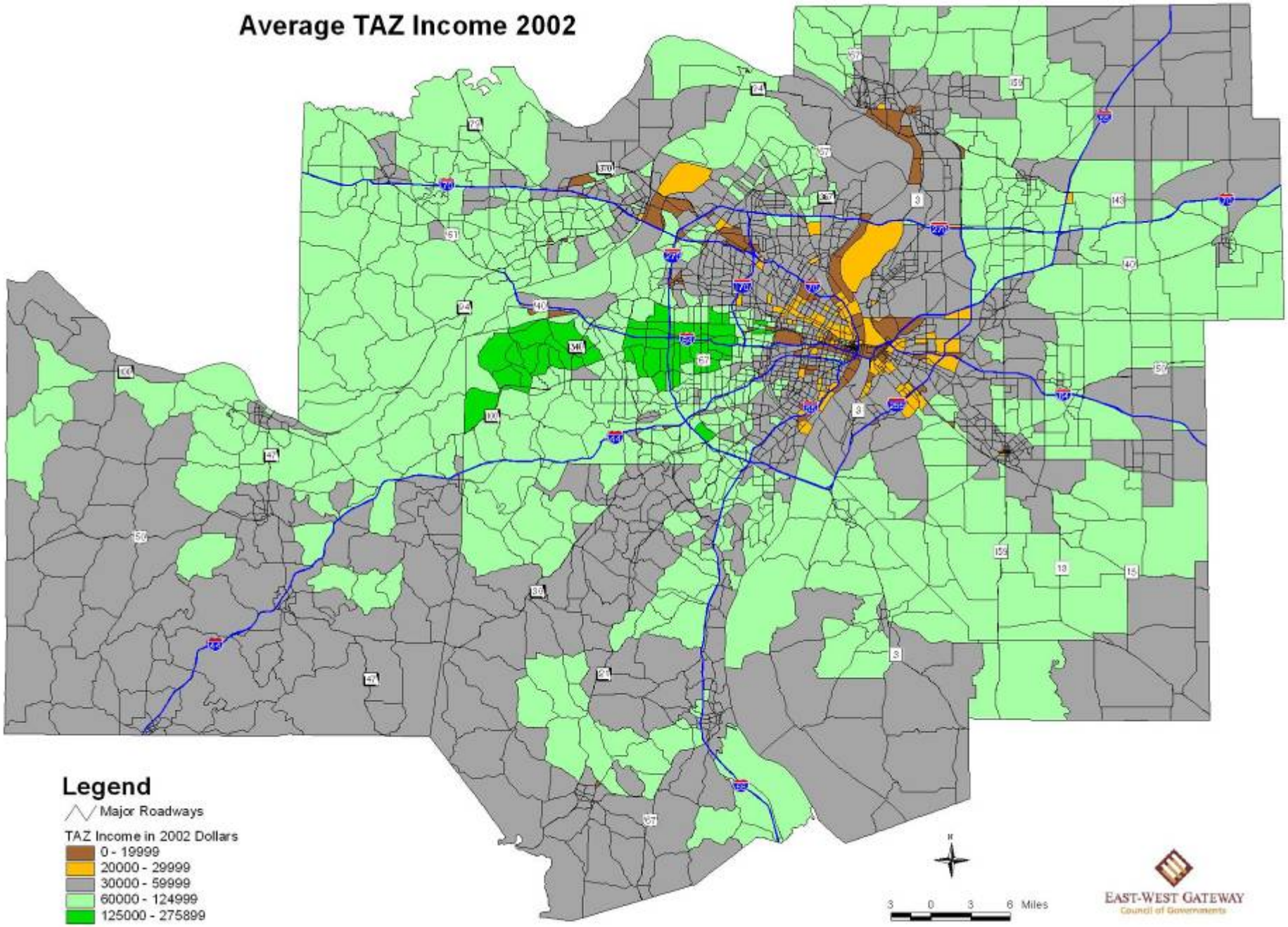
- County-level forecasts
  - Growth Trends
  - Holding Capacity
  - Development Outlook and Potential

- Employment Categories:
  - Employment = Retail + Non-Retail Employment
  - Non-Retail Employment = Basic + Service Employment

Rates of Change: Historic and Forecast

				Annual Compound Percent Growth	
	1990	2000	2035	1990-2000	2000-2035
Population	2,389,616	2,482,942	2,814,819	0.38%	0.36%
Households	904,743	968,262	1,238,536	0.68%	0.71%
Employment	1,140,182	1,303,584	1,494,129	1.35%	0.39%
Population Density (per mi^2)	533	553	627	0.37%	0.36%
Employment Density (per mi^2)	254	291	333	1.37%	0.39%

Average TAZ Income 2002



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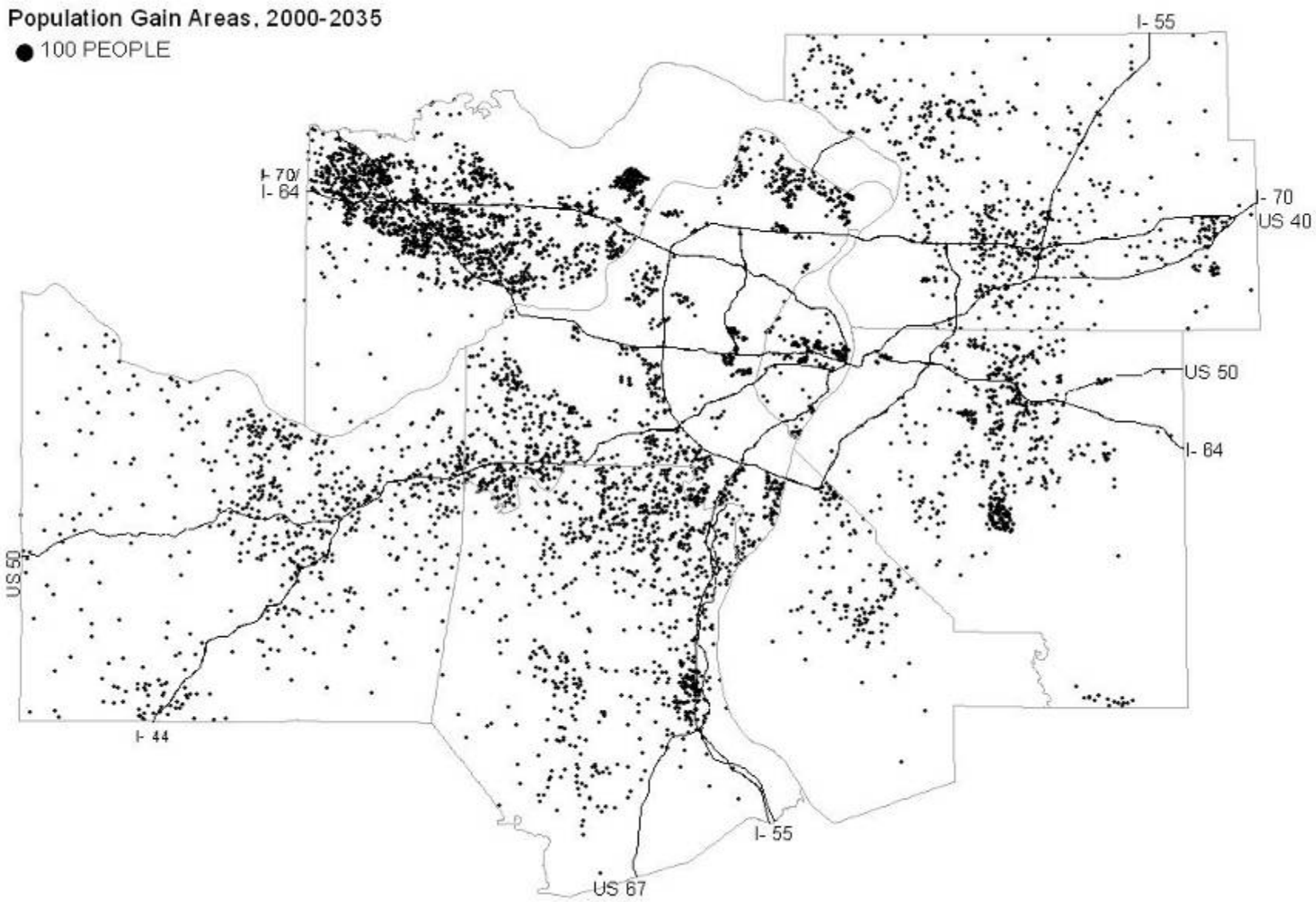

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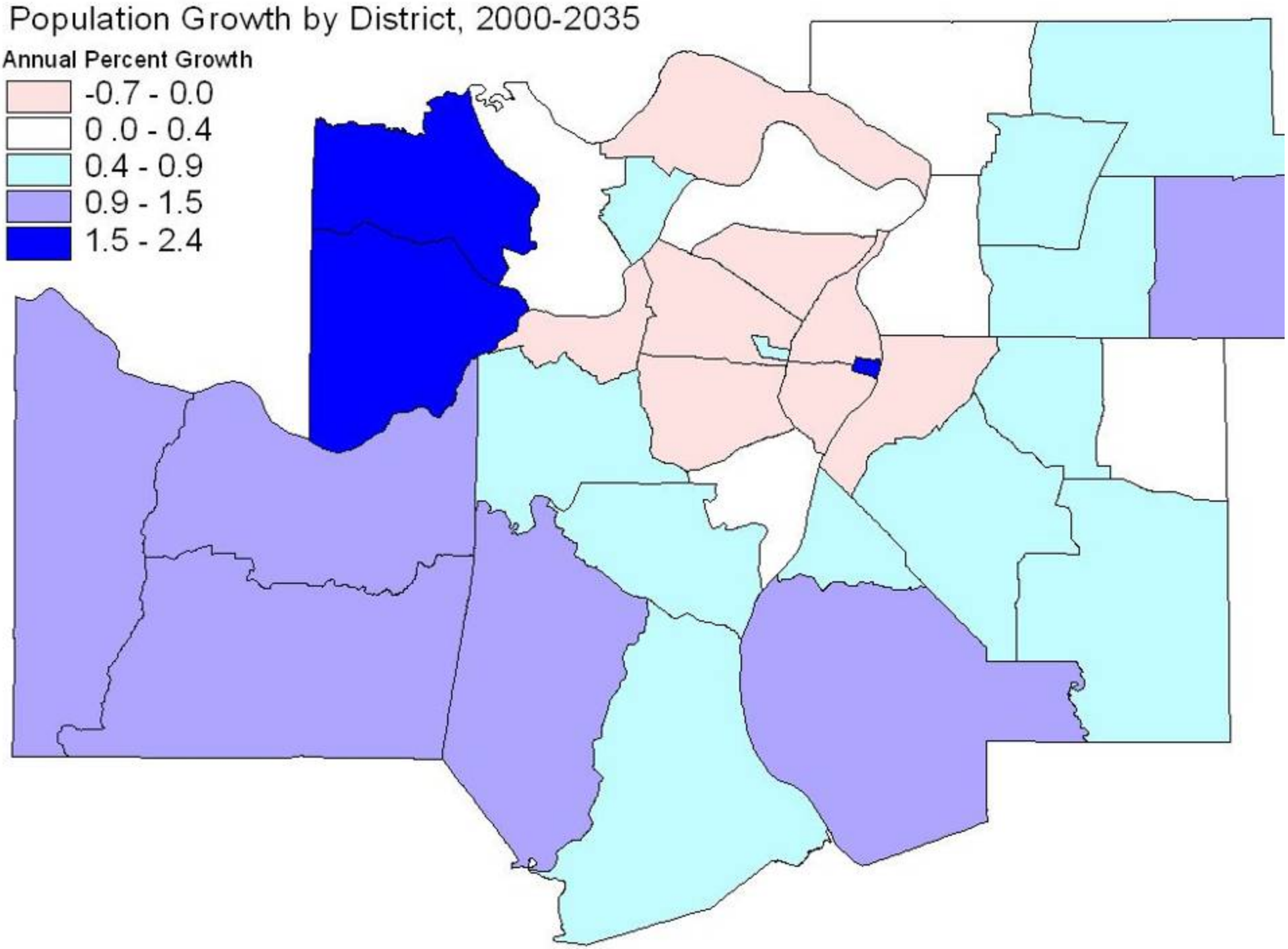
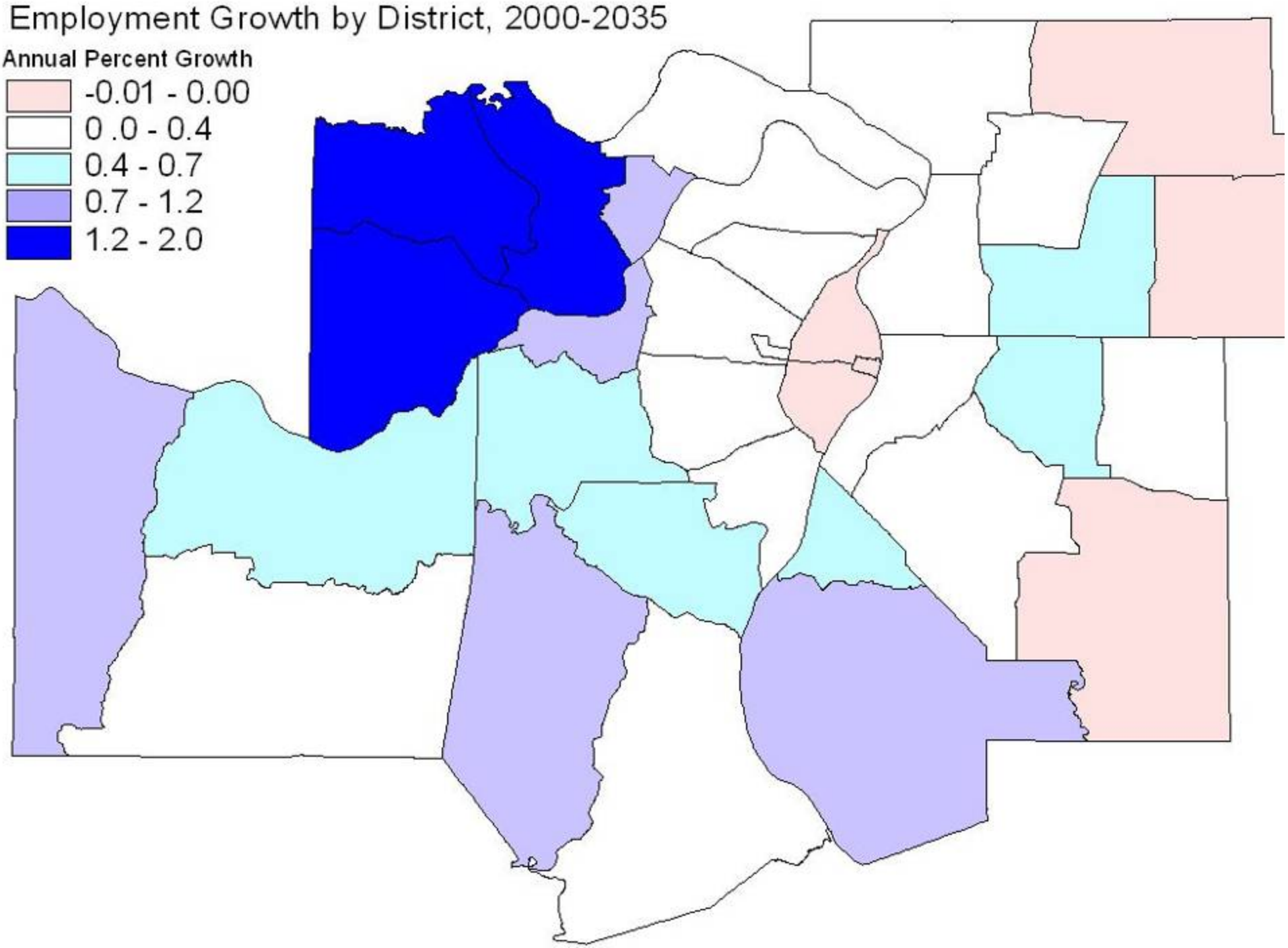
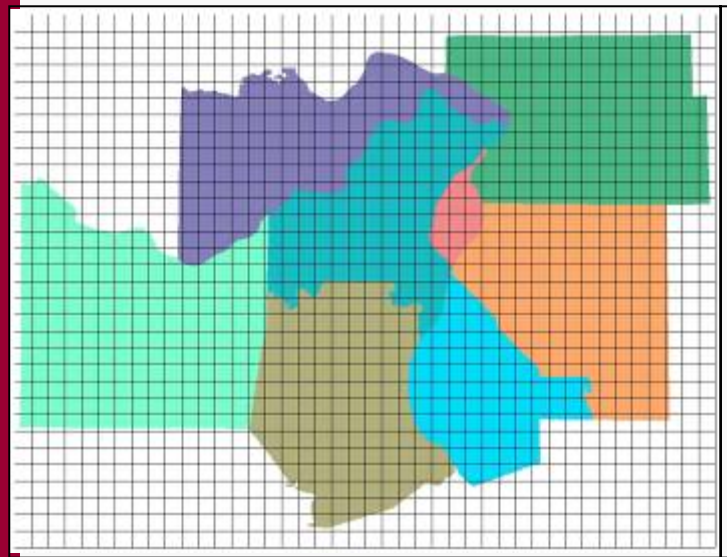

Population Growth by District, 2000-2035
Annual Percent Growth
-0.7 - 0.0
0 .0 - 0.4
0.4 - 0.9
0.9 - 1.5
1.5 - 2.4


Employment Growth by District, 2000-2035
Annual Percent Growth
-0.01 - 0.00
0 .0 - 0.4
0.4 - 0.7
0.7 - 1.2
1.2 - 2.0

Future Directions: the Land Use Evolution and Assessment Model (LEAM)

- Developed at University of Illinois Urbana-Champaign (UIUC) Department of Urban Planning.
- Partners with National Center for Supercomputing at UIUC.
- Suite of Models: Economic, Demographic, Fiscal
- Simulates Land Use Change
- Developed Blueprint Model for EWGCOG

How does LEAM work?



30 meter x 30 meter grid	Drivers	Scenarios
	• Proximity to Interstates • Proximity to Intersections • Employment Centers • Cultural Centers • Population Centers • Characteristics of Neighbors • And more……	• New Roads • New Metrolink • New Policies • Economic Change • Population Change • What Else?

PROBABILITY OF LAND-USE CHANGE

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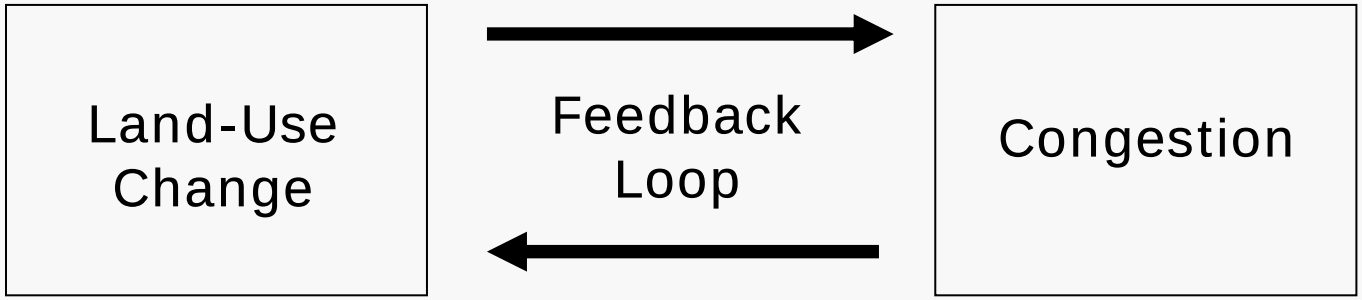
Integrating Land-Use and Transportation Models



- Central Assumption: Probability of development decreases in congested areas, pushing developmental pressure to adjacent areas.
  (Contributes to "Leapfrog" Development)
- Retail is an exception: Attracted to Congestion.

- Modeling Principles:
  - $Congestion_t = f(Land\text{-}Use_t)$
  - $Land\ Use_{t+1} = f(Congestion_t + X)$

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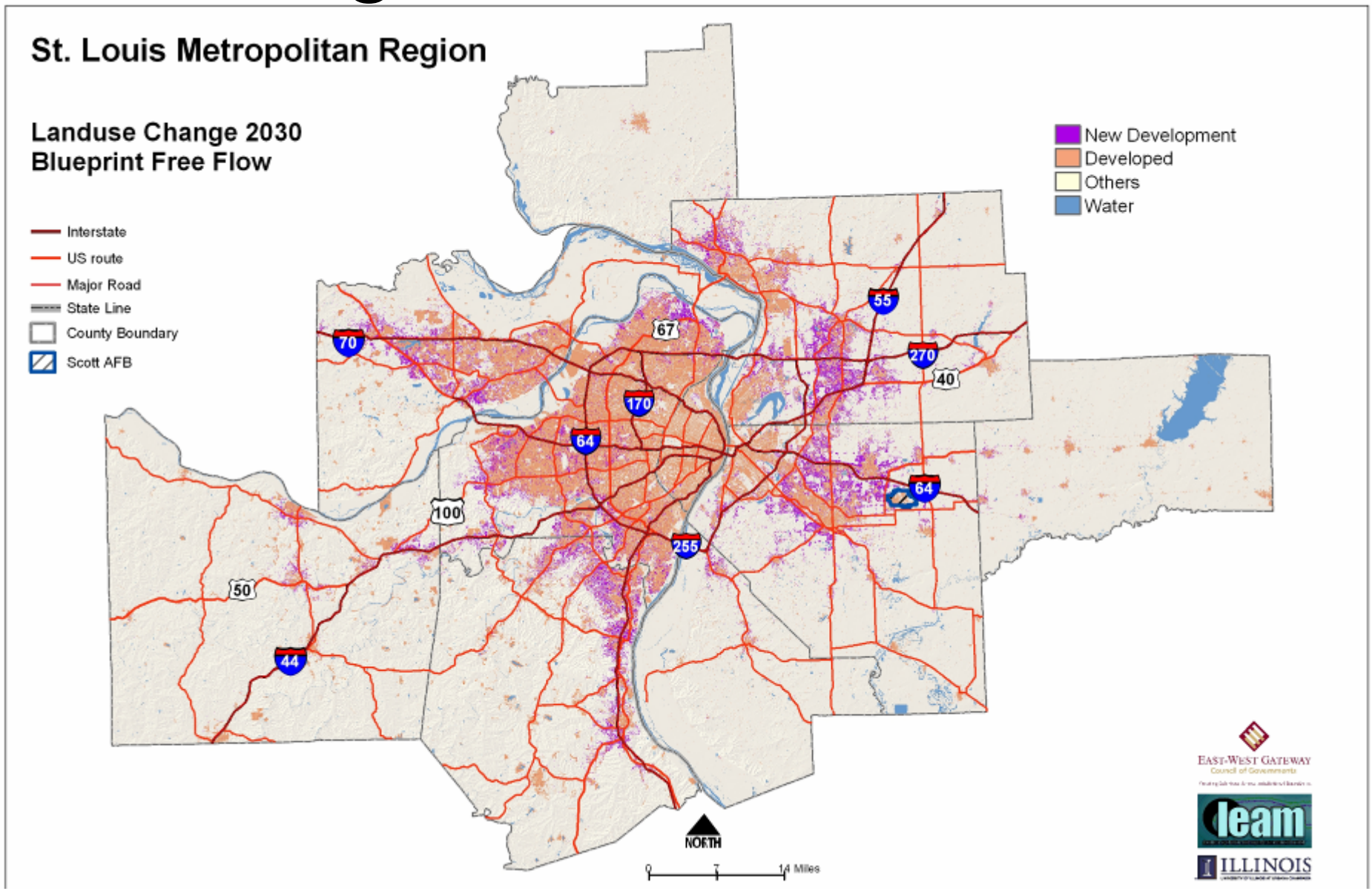
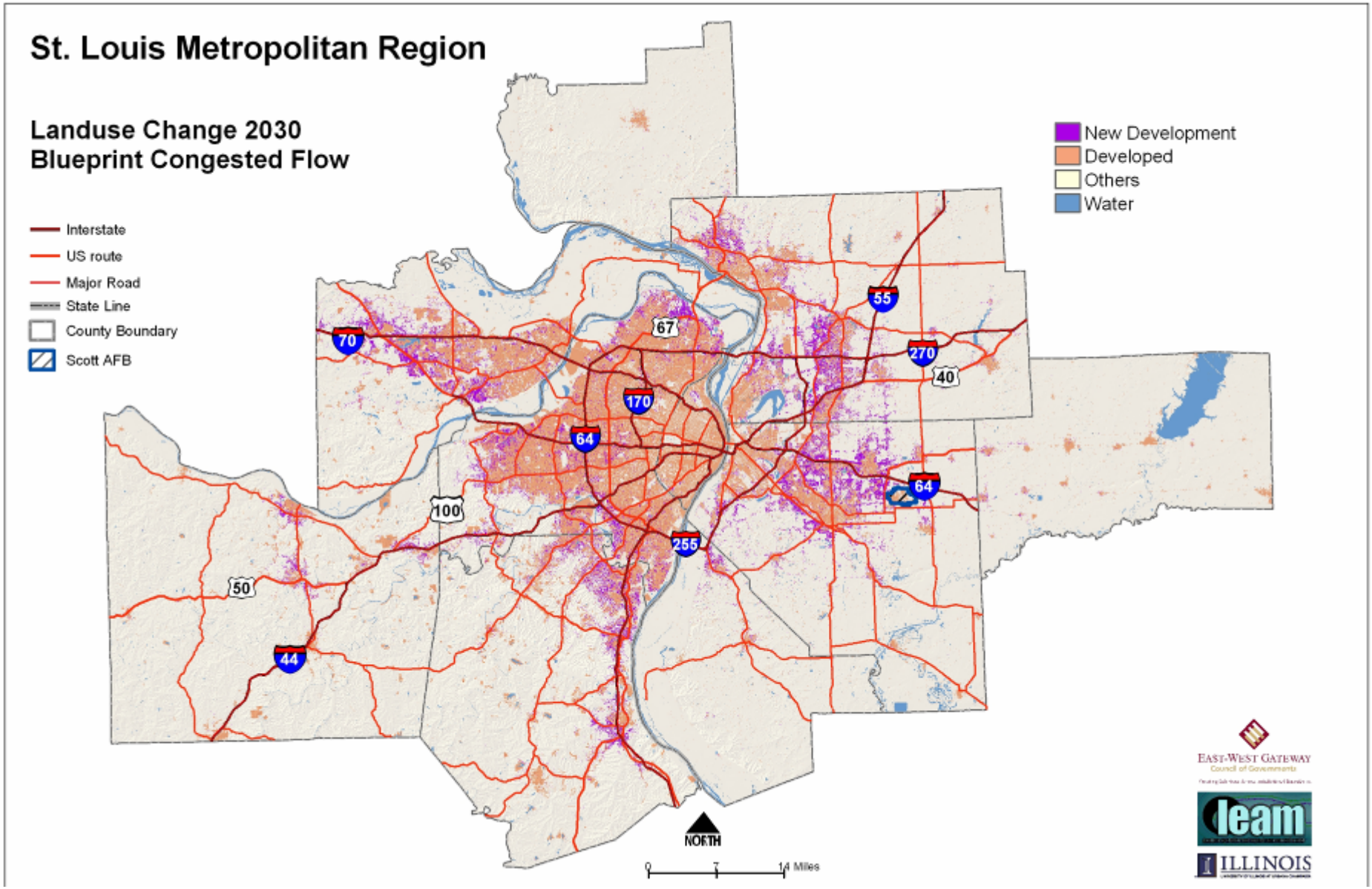
Static Free-Flow Land-Use Change



Static Congested Land-Use Change



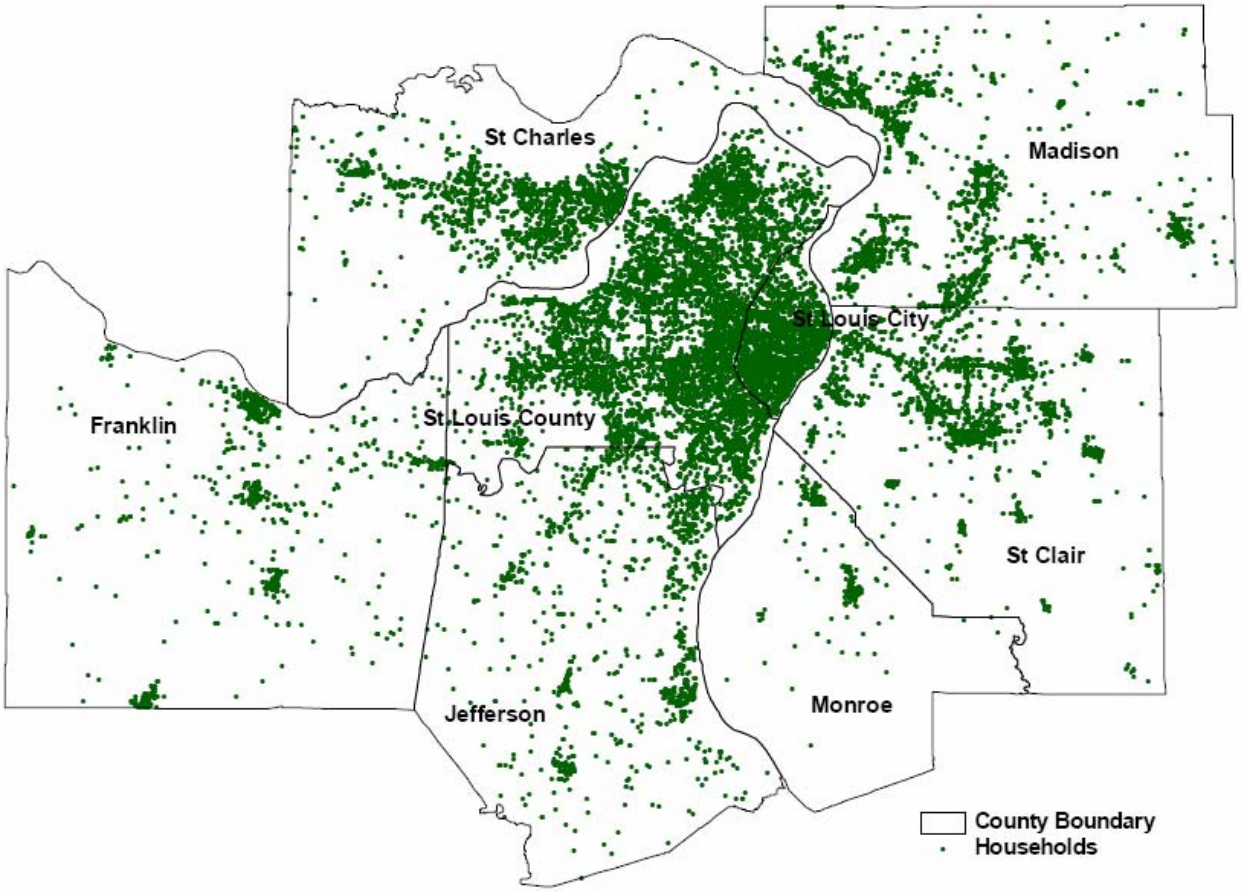
Household Interview Survey

- Survey Universe = All Households with a Telephone in the 8 County St. Louis Region.
- Personal 24 hr Travel Journals Recorded from April-May and September- December 2002.
- Weekdays Only

Household Interview Survey

- 5,094 Households
- 11,490 Persons
- 10,218 Vehicles
- 46,909 Unlinked Trips

Geographic Distribution of Sampled Households



Data collected by NuStats
Coverage data provided by East-West Gateway Council 2002.
Projection: State Plane NAD 1983 Missouri East

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Key Household Statistics
(Expanded)

Variable	St. Louis Region
Total Households	968,533
Total Persons	2,428,730
Persons per HH	2.51
Total Workers	1,173,772
Workers per HH	1.22
Total Vehicles	1,637,553
Vehicles per HH	1.69

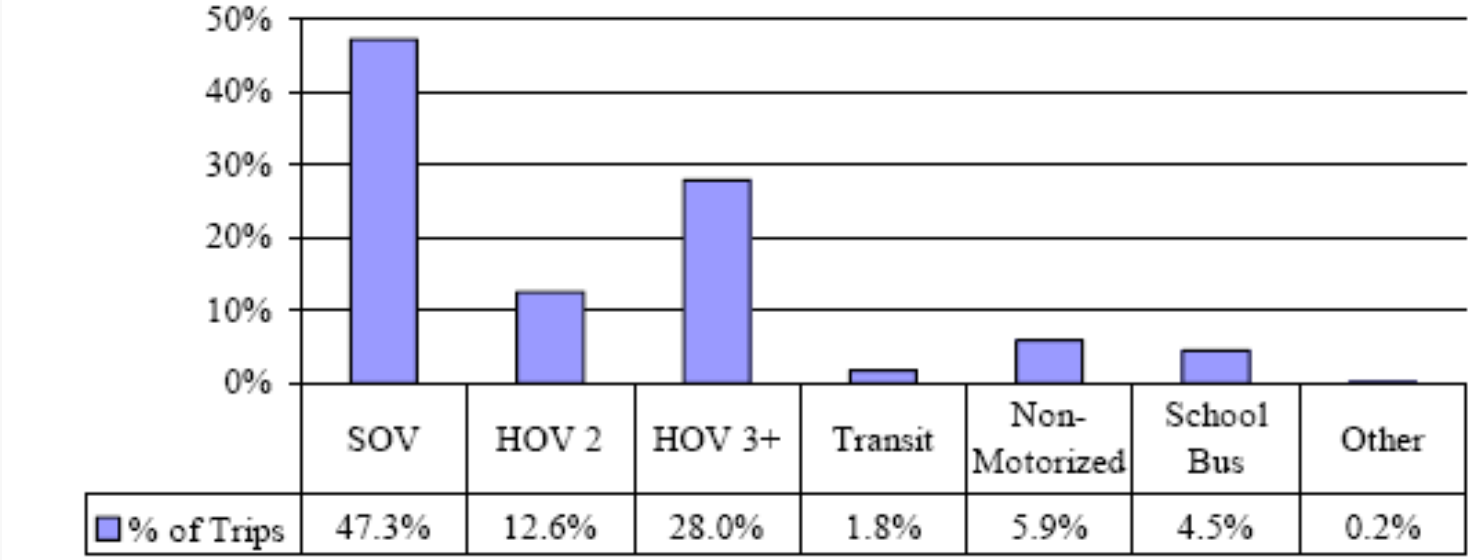
Source: NuStats

Key Trip Statistics
(Expanded)

Variable	St. Louis Region
Total Person Trips3	9,457,294
Mean Trips per HH	9.76
Mean Trips per Person	3.89
Mean Trip Duration (minutes)	17.87
Mean Work Trip Duration (minutes)	22.57
Total Vehicle Trips4	8,316,427
Total Transit Trips5	150,495
Total School bus Trips	422,319
Total Non-motorized Trips6	553,310

Source: NuStats

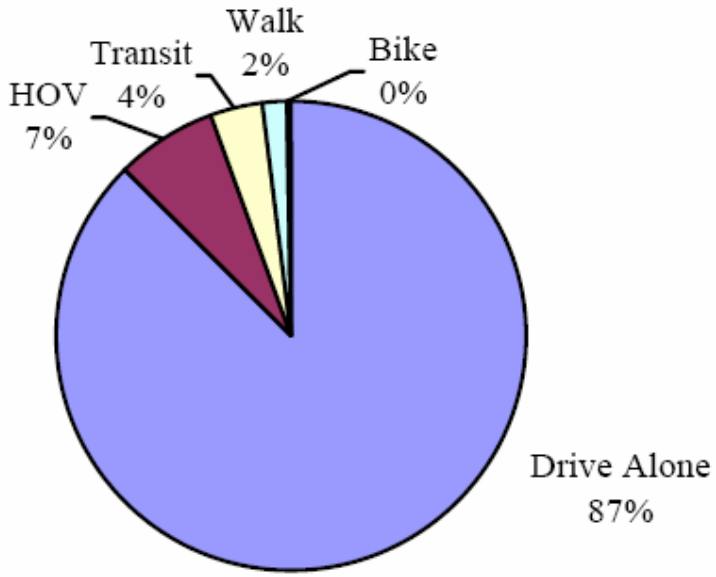
Mode of Travel for Daily Person Trips



	SOV	HOV 2	HOV 3+	Transit	Non-Motorized	School Bus	Other
% of Trips	47.3%	12.6%	28.0%	1.8%	5.9%	4.5%	0.2%

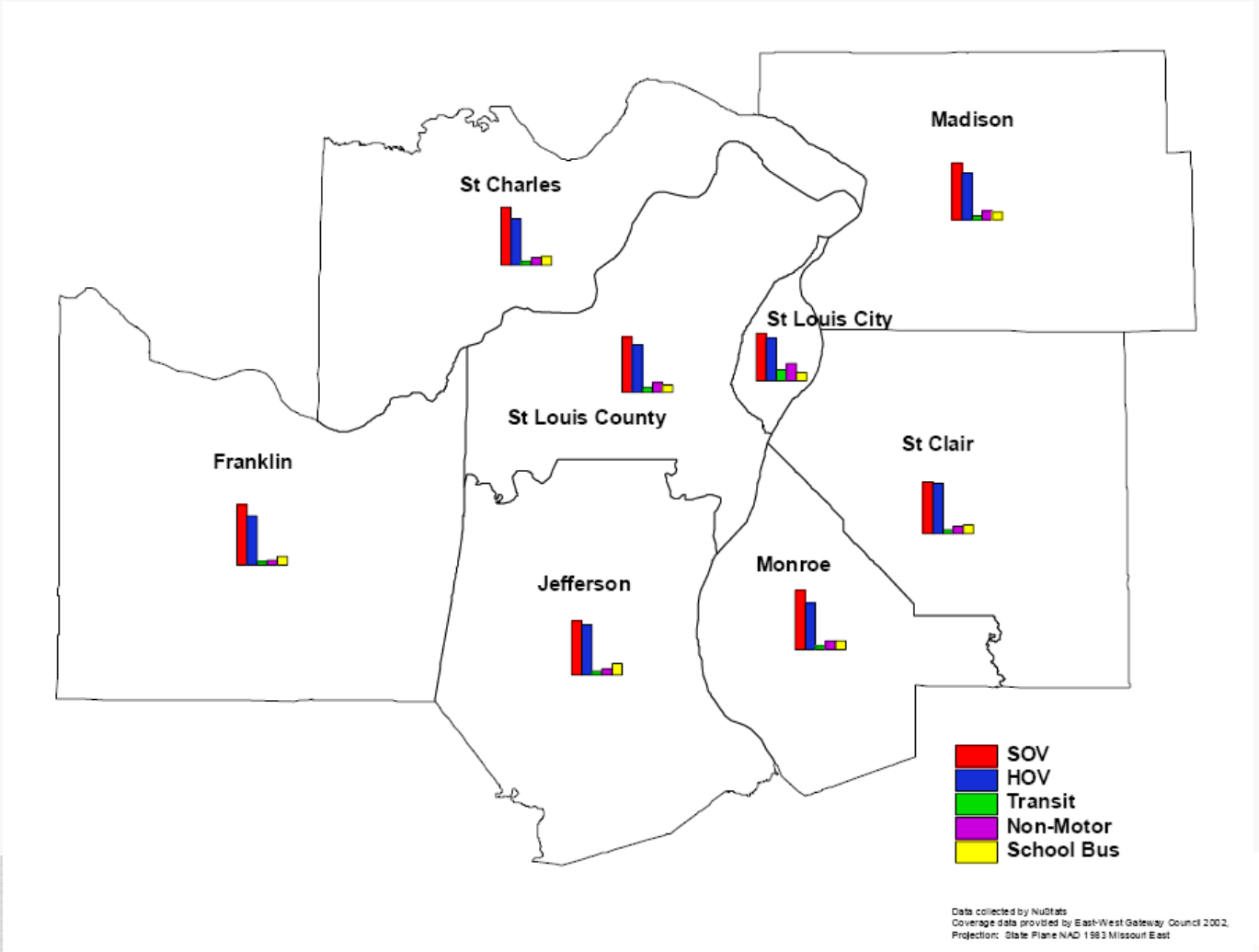
Source: NuStats

Usual Mode To Main Job



Source: NuStats

Mode of Travel by Home County



Source: NuStats

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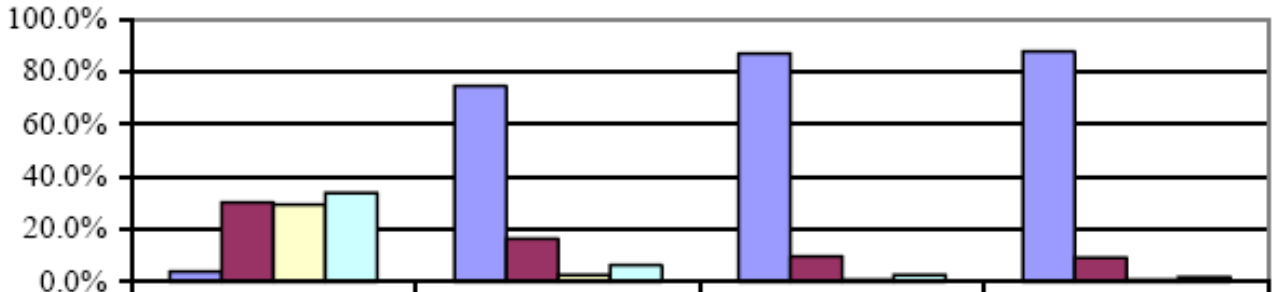
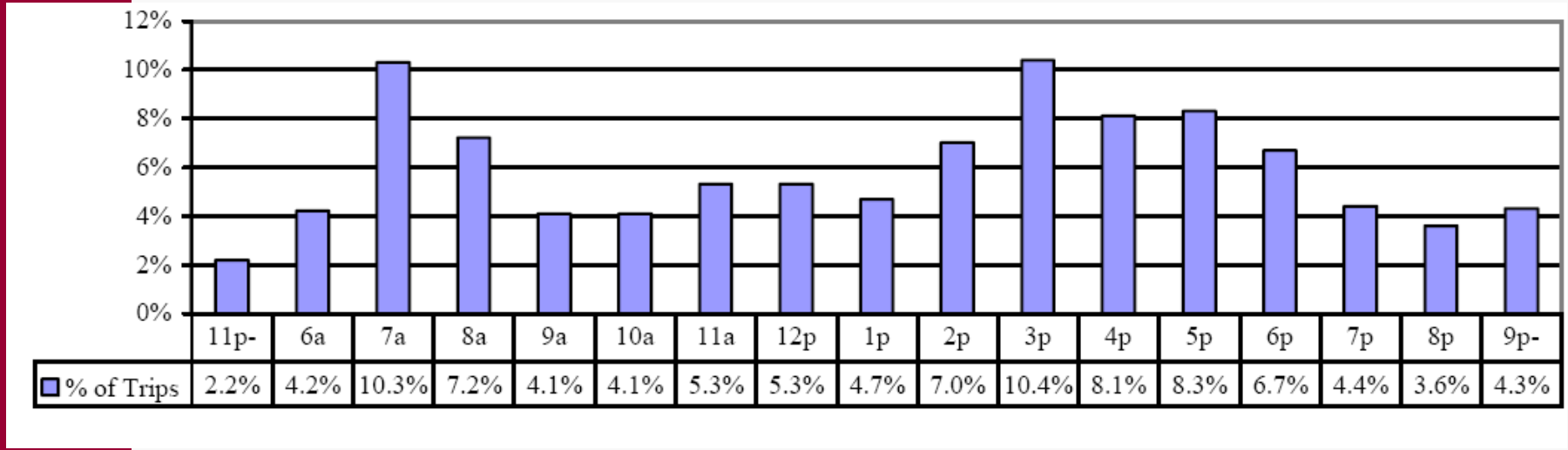
Main Mode of Trip to Work by Vehicle Ownership



	0	1	2	3+
SOV	3.7%	74.4%	86.9%	87.6%
HOV	30.2%	16.4%	9.7%	9.4%
Transit	29.2%	2.8%	0.7%	0.9%
Non-Motor	33.9%	6.2%	2.7%	1.9%

Source: NuStats

Trip Distribution by Departure Hour



	11p-	6a	7a	8a	9a	10a	11a	12p	1p	2p	3p	4p	5p	6p	7p	8p	9p-
% of Trips	2.2%	4.2%	10.3%	7.2%	4.1%	4.1%	5.3%	5.3%	4.7%	7.0%	10.4%	8.1%	8.3%	6.7%	4.4%	3.6%	4.3%

Source: NuStats

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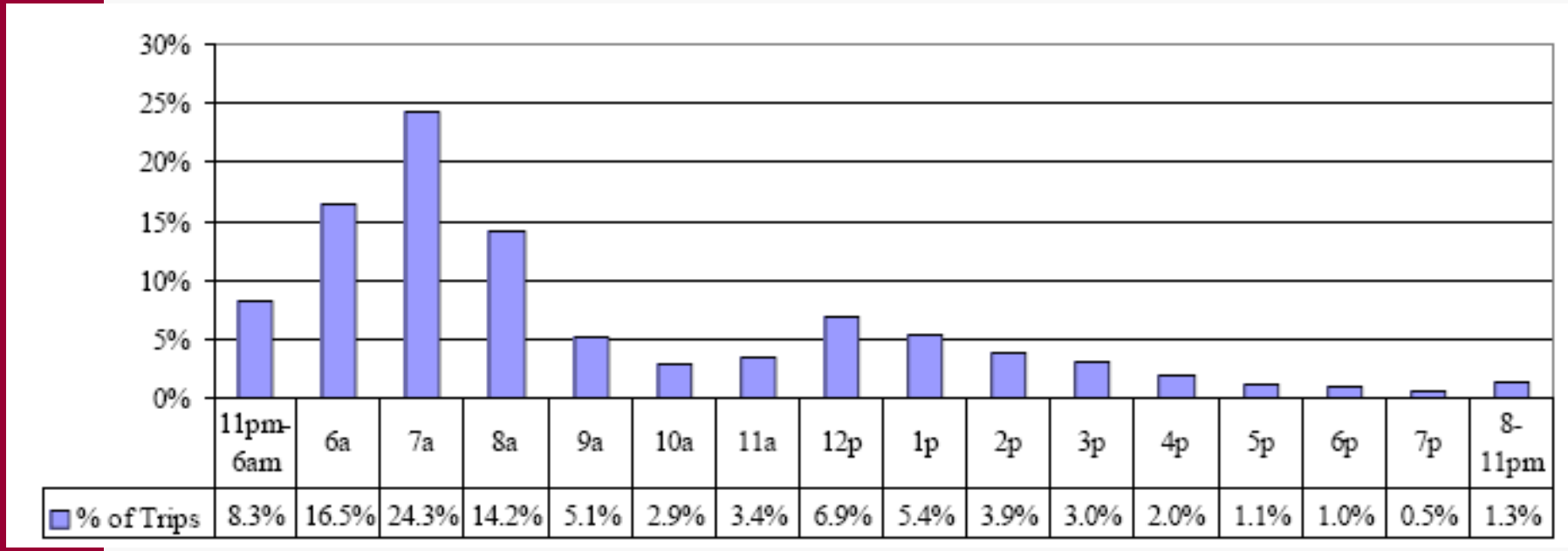
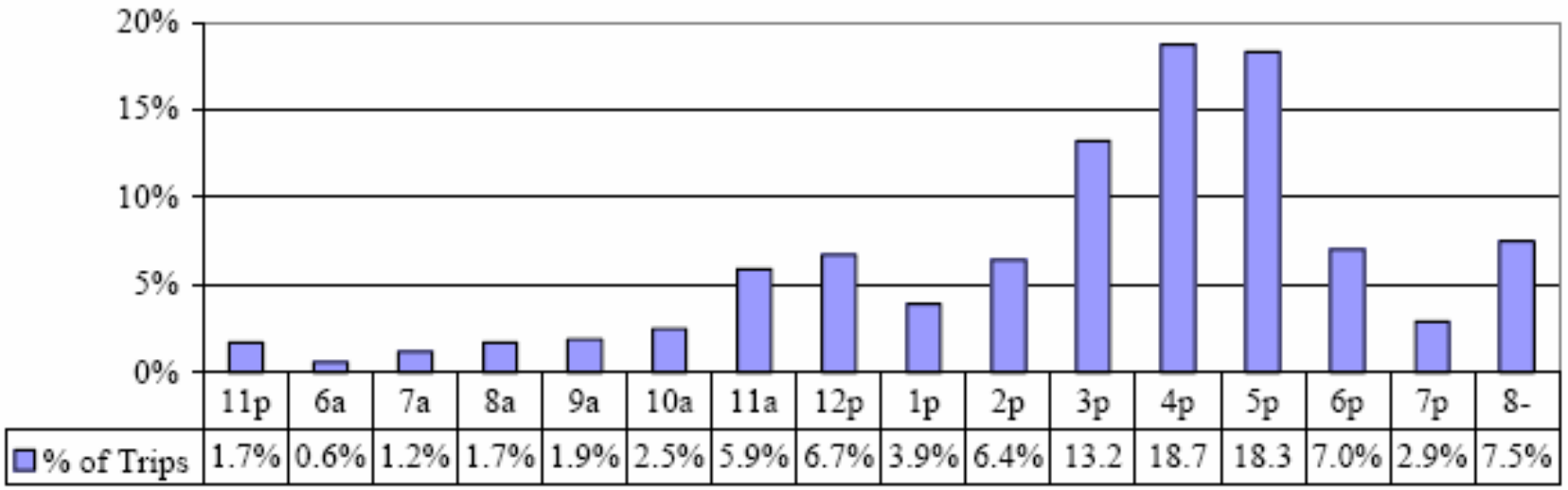
Starting Hour for Trips to Work



	11pm-6am	6a	7a	8a	9a	10a	11a	12p	1p	2p	3p	4p	5p	6p	7p	8-11pm
% of Trips	8.3%	16.5%	24.3%	14.2%	5.1%	2.9%	3.4%	6.9%	5.4%	3.9%	3.0%	2.0%	1.1%	1.0%	0.5%	1.3%

Source: NuStats

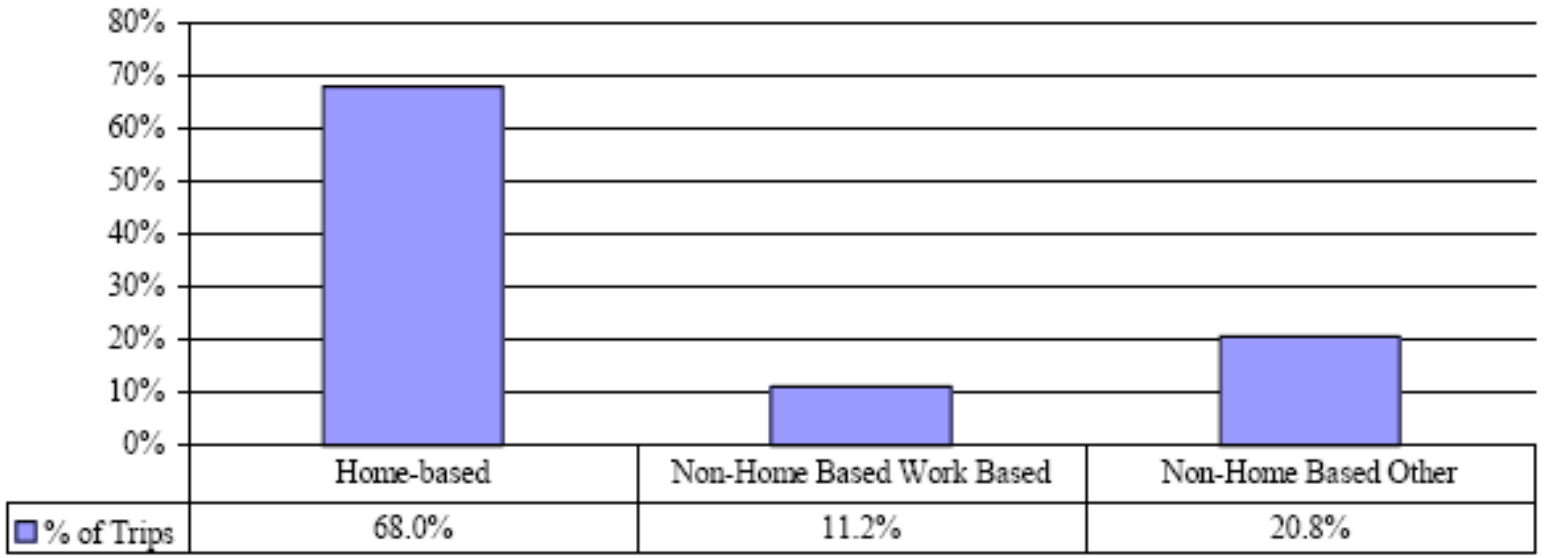
Starting Hour for Trips From Work



	11p	6a	7a	8a	9a	10a	11a	12p	1p	2p	3p	4p	5p	6p	7p	8-
% of Trips	1.7%	0.6%	1.2%	1.7%	1.9%	2.5%	5.9%	6.7%	3.9%	6.4%	13.2	18.7	18.3	7.0%	2.9%	7.5%

Source: NuStats

Summarized Trip Purposes



Source: NuStats

Trip Origins and Destinations AM Peak By County

County	Trip Origins	%	Trip Destinations	%
St. Louis County	533,370	39.0	547,362	40.0
St. Louis City	189,220	13.8	266,272	19.4
St. Charles County	159,020	11.6	131,516	9.6
St. Clair County	151,638	11.1	135,644	9.9
Madison County	138,840	10.1	120,132	8.8
Jefferson County	112,322	8.2	80,282	5.9
Franklin County	61,951	4.5	55,532	4.1
Monroe County	18,657	1.4	16,852	1.2
Out of Area	4,279	0.3	15,704	1.1
Total	**1,369,297**	**100.0**	**1,369,297**	**100.0**

Source: NuStats

Trip Origins and Destinations PM Peak By County

County	Trip Origins	%	Trip Destinations	%
St. Louis County	930,504	42.5	956,953	44.5
St. Louis City	297,846	13.6	284,716	13.2
St. Charles County	241,663	11.0	229,352	10.7
St. Clair County	231,409	10.6	234,693	10.9
Madison County	223,525	10.2	206,659	9.4
Jefferson County	148,717	6.8	125,782	5.7
Franklin County	72,183	3.3	68,482	3.1
Monroe County	22,575	1.0	19,034	0.9
Out of Area	20,794	0.9	26,763	1.2
Total	**2,240,815**	**100.0**	**2,240,815**	**100.0**

Source: NuStats

Trips by Household Size

Household (HH) Size	# HHs	Percent	# Trips	Percent	Trips/HH
1	268,090	27.7	1,072,887	11.3	4.00
2	308,670	31.9	2,417,433	25.6	7.83
3	160,997	16.6	1,838,116	19.4	11.42
4	138,538	14.3	2,245,794	23.7	16.21
5	62,211	6.4	1,186,788	12.5	19.08
6	20,209	2.1	481,137	5.1	23.81
7+	9,818	1.0	215,139	2.3	21.91
Total	**968,533**	**100.0**	**9,457,294**	**100.0**	**9.76**

Source: NuStats

Trips by Number of HH Workers

Workers	# HHs	%	# Trips	%	Trips/HH
0	233,176	24.1	1,226,755	13.0	5.26
1	372,953	38.5	3,367,128	35.6	9.03
2	300,040	31.0	3,812,254	40.3	12.71
3+	62,363	6.4	1,051,156	11.1	16.86
Total	**968,533**	**100.0**	**9,457,293**	**100.0**	**9.76**

Source: NuStats

Trips by Household Income

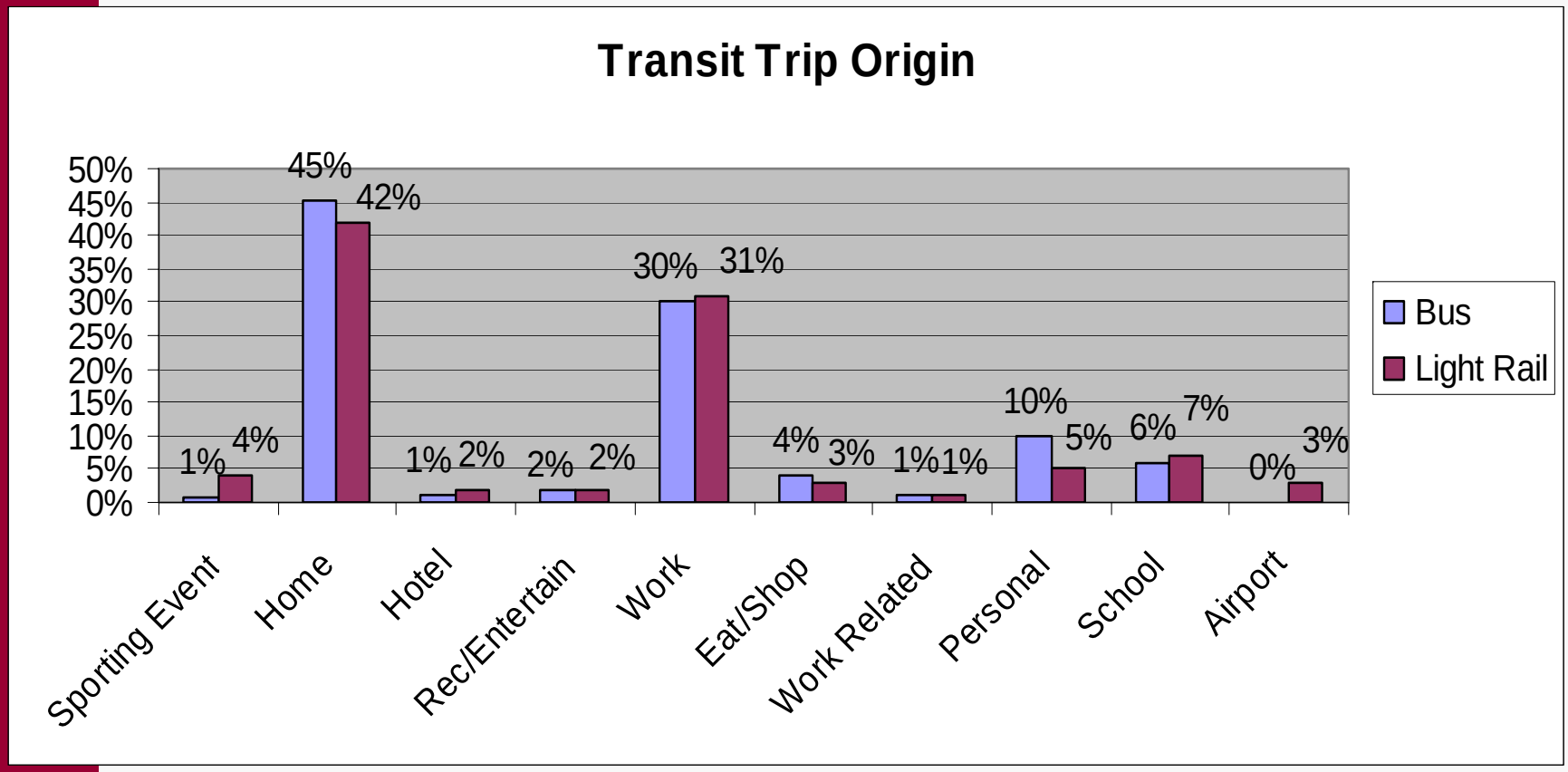
HH Income	#HHs	Percent	# Trips	Percent	Trips/HH
Less than $4,999	22,393	2.3	105,249	1.3	4.70
$5,000 to $14,999	59,556	6.1	275,027	3.3	4.62
$15,000 to $24,999	98,710	10.2	693,757	8.4	7.03
$25,000 to $44,999	206,898	21.4	1,660,601	20.1	8.03
$45,0000 to $74,999	231,330	23.9	2,597,017	31.5	11.23
$75,0000 or more	215,905	22.3	2,910,747	35.3	13.48
Missing	133,742	13.8	--	--	--
Total	**968,534**	**100.0**	**8,242,398**	**100.0**	**9.76**

Source: NuStats

On Board Passenger Survey

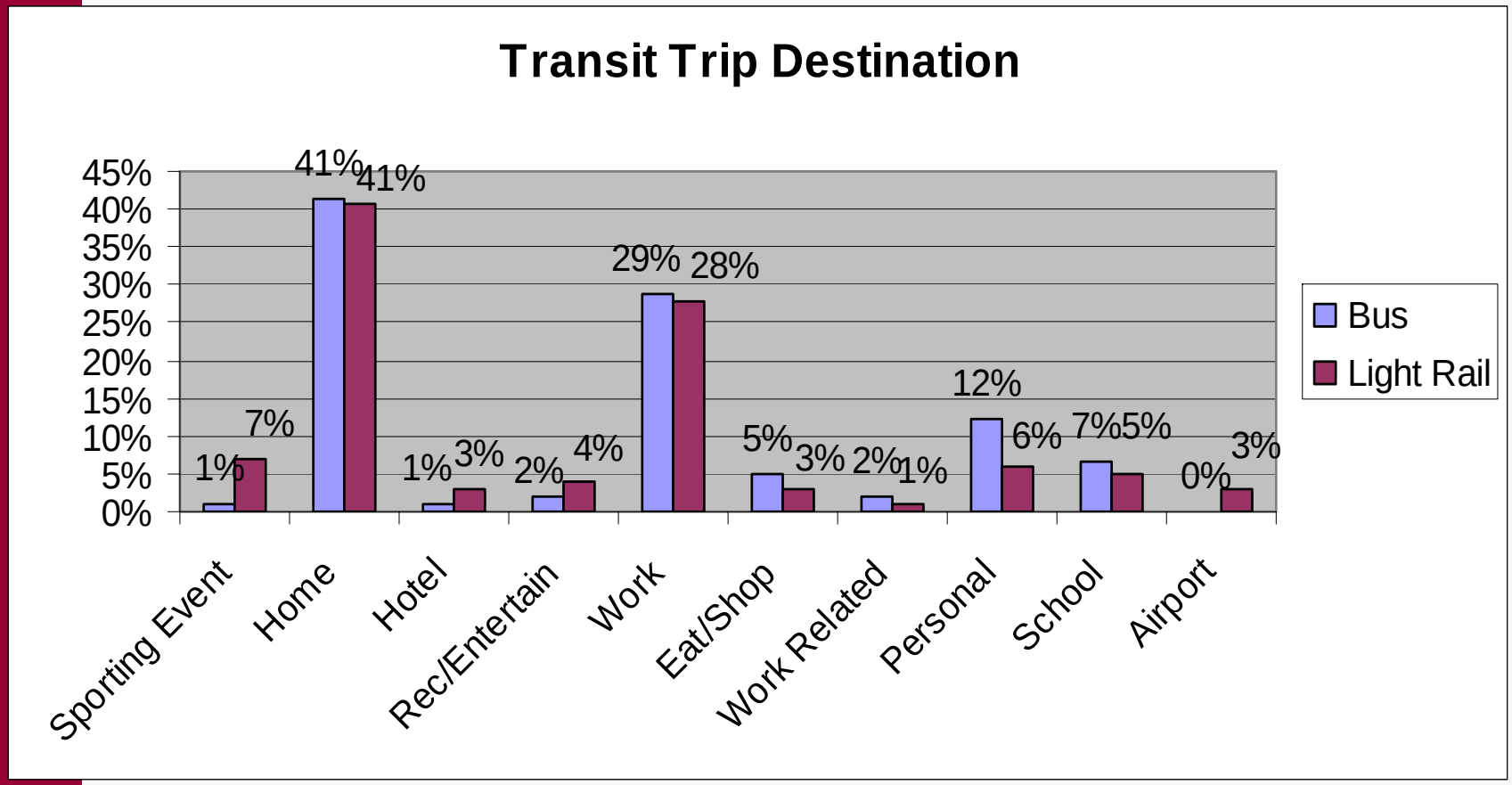
- Survey of All Fixed Route Transit Service
- March-April 2002
- 15,321 Surveys Returned From Adult Passengers (16+)
- 68% Response Rate
- 13,535 Bus
- 1,786 LRT

On Board Passenger Survey



EAST-WEST GATEWAY
Council of Governments
Creating Solutions Across Jurisdictional Boundaries

On Board Passenger Survey



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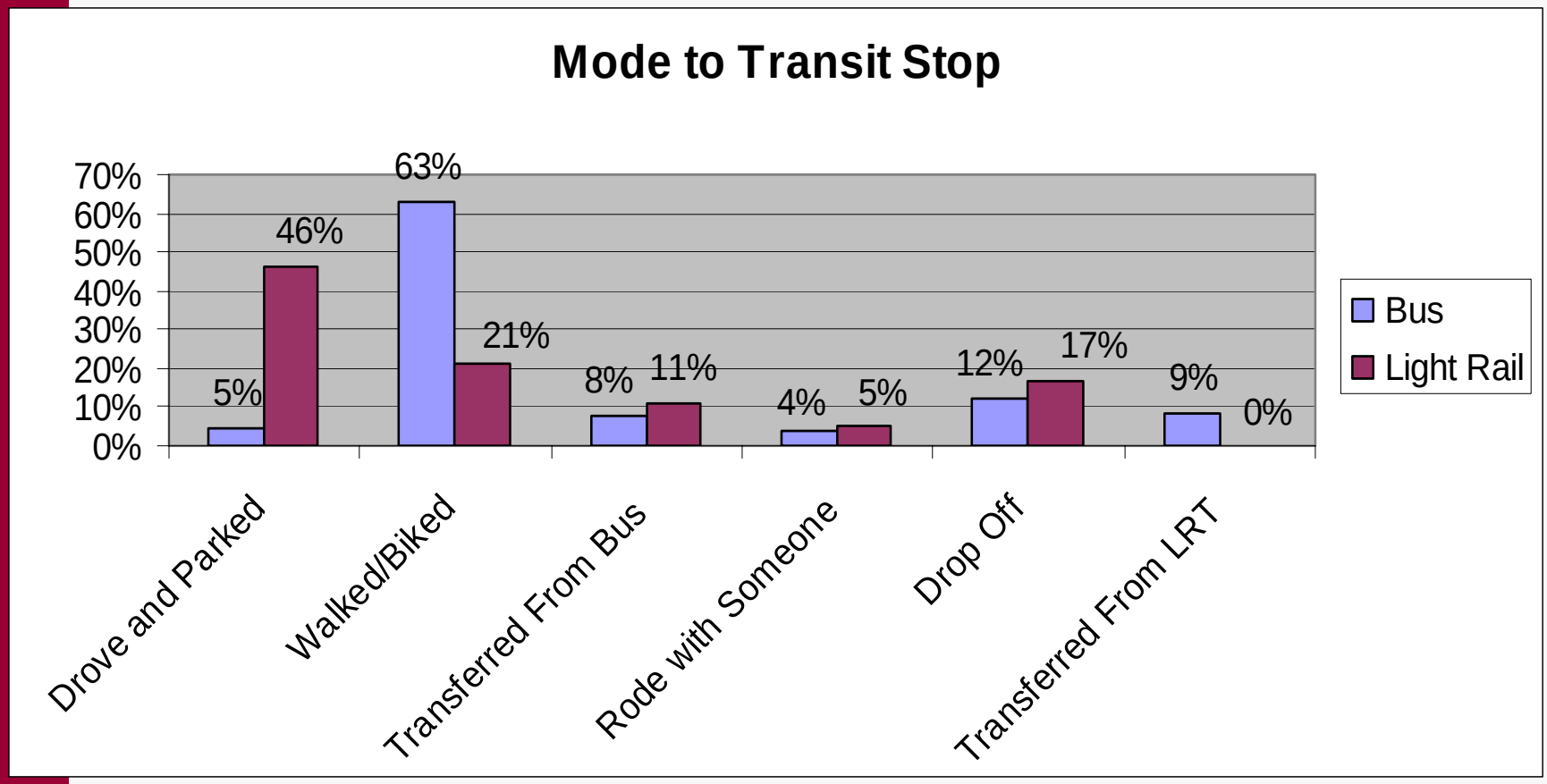
On Board Passenger Survey



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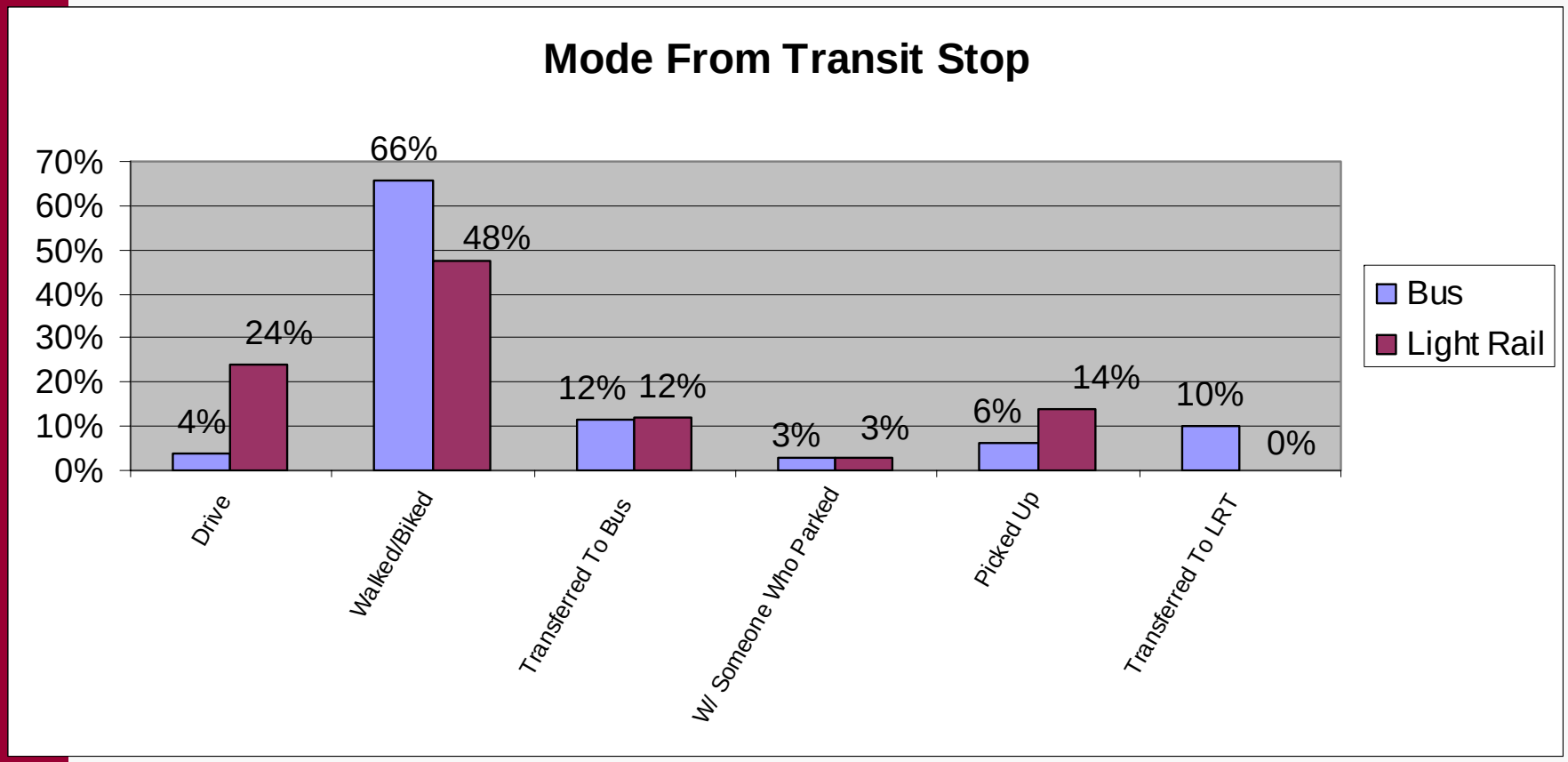
On Board Passenger Survey



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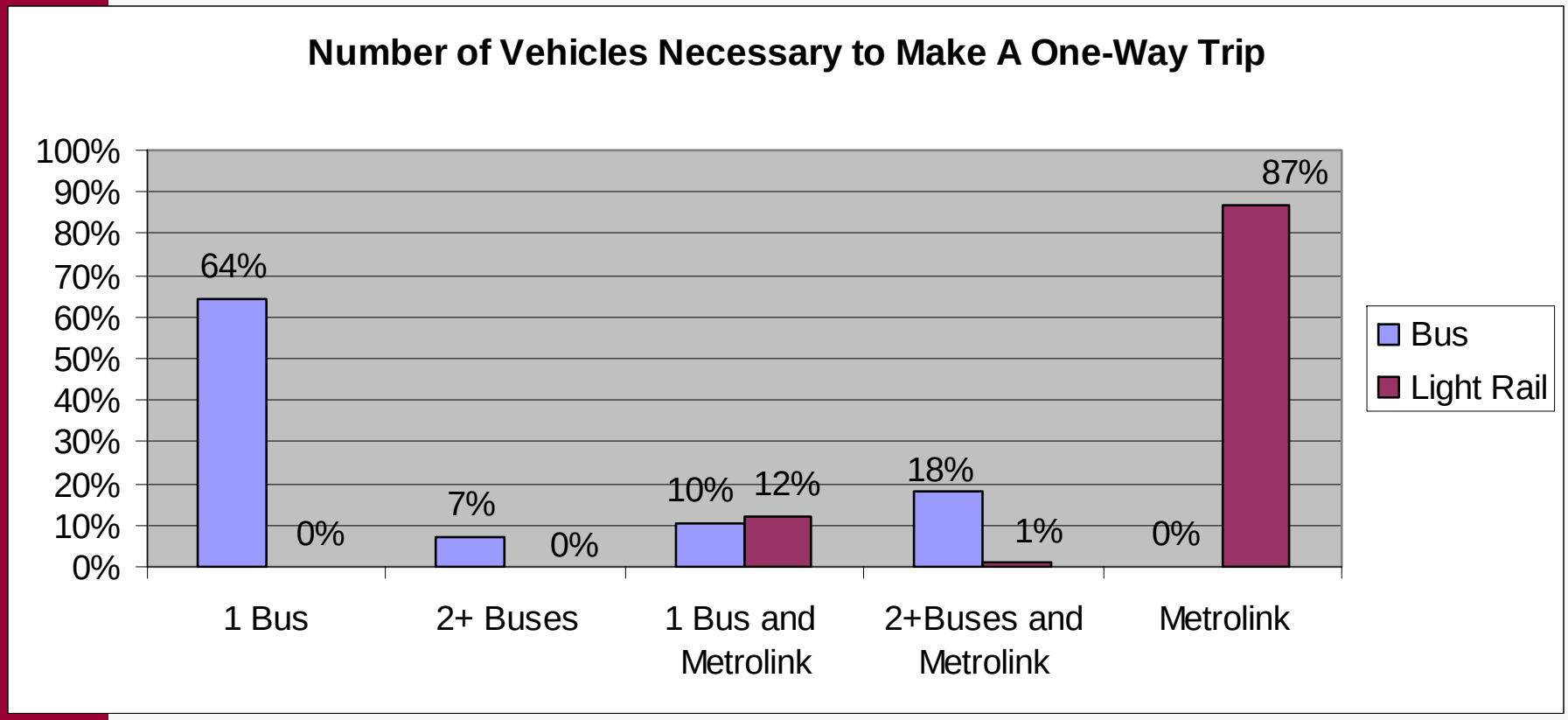
On Board Passenger Survey



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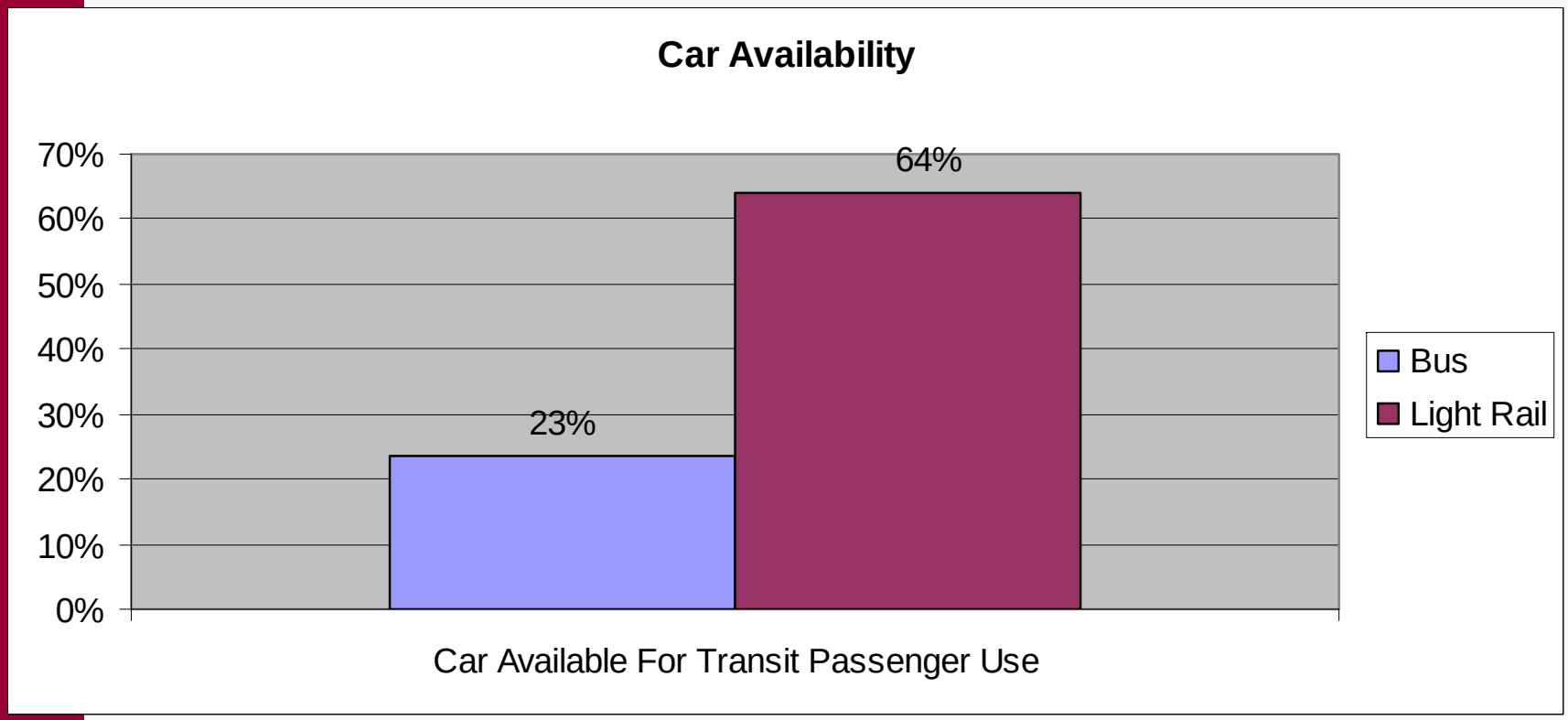
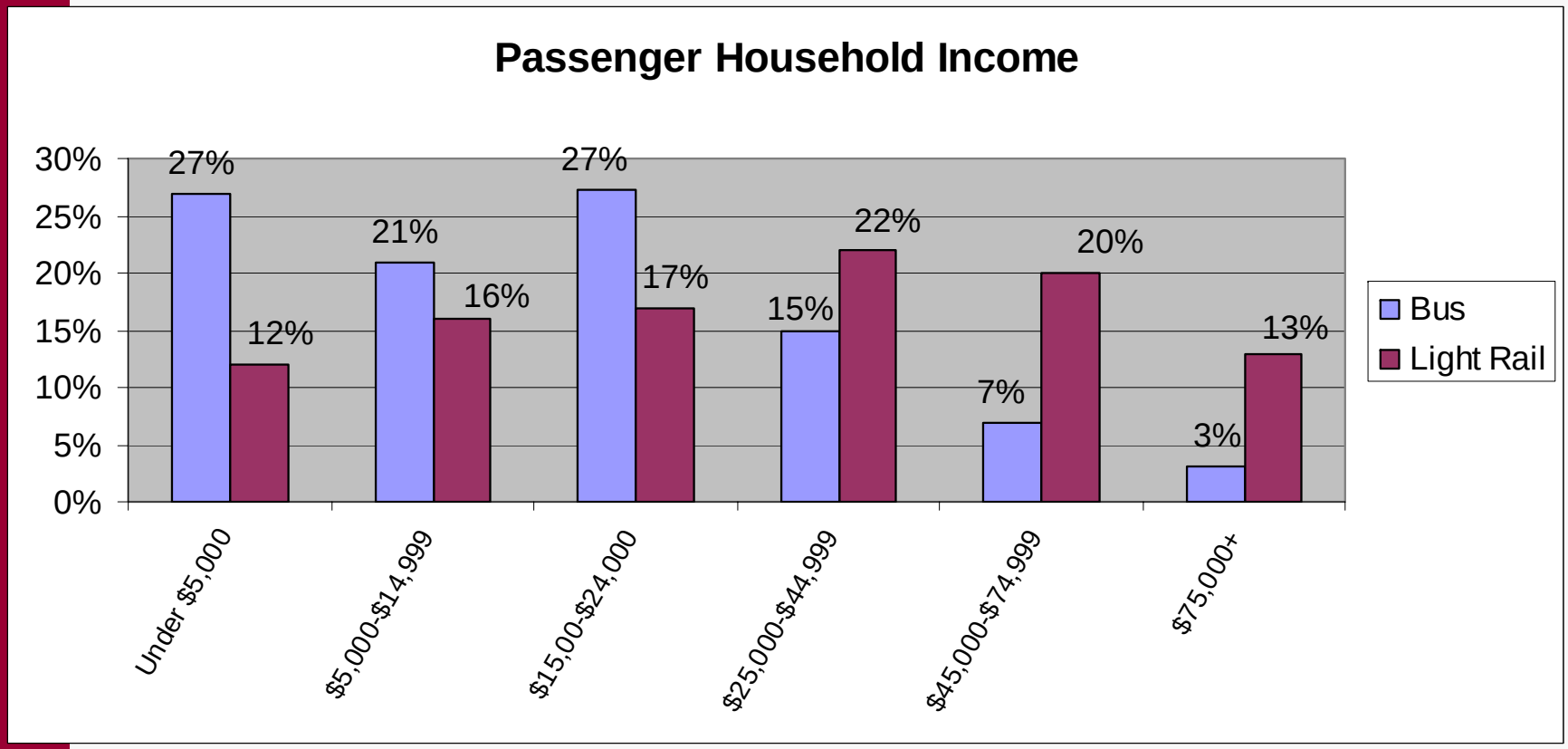
On Board Passenger Survey



On Board Passenger Survey



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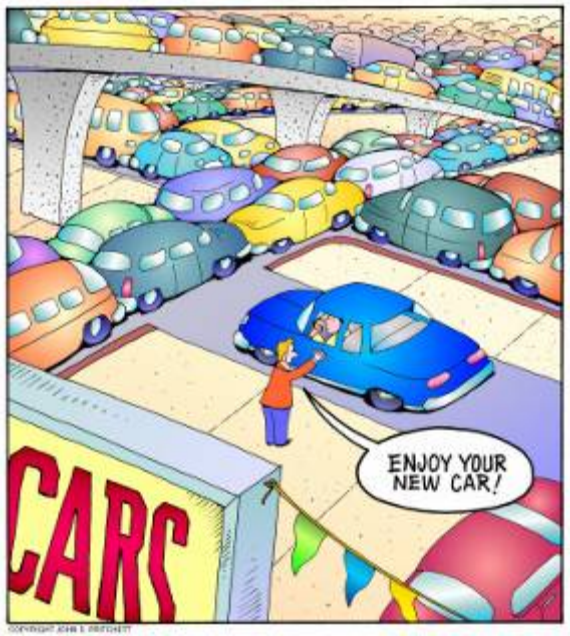
Transportation Networks: Topics

- Highway Network
  - Revised on 2002
- Transportation Analysis Zone
  - Redefined on 2002
- Area Type Model
  - New Effort



St. Louis MO-IL: 2002 Highway Network

TEval Model Highway Network includes all roadway functionally classified as Collector and up.

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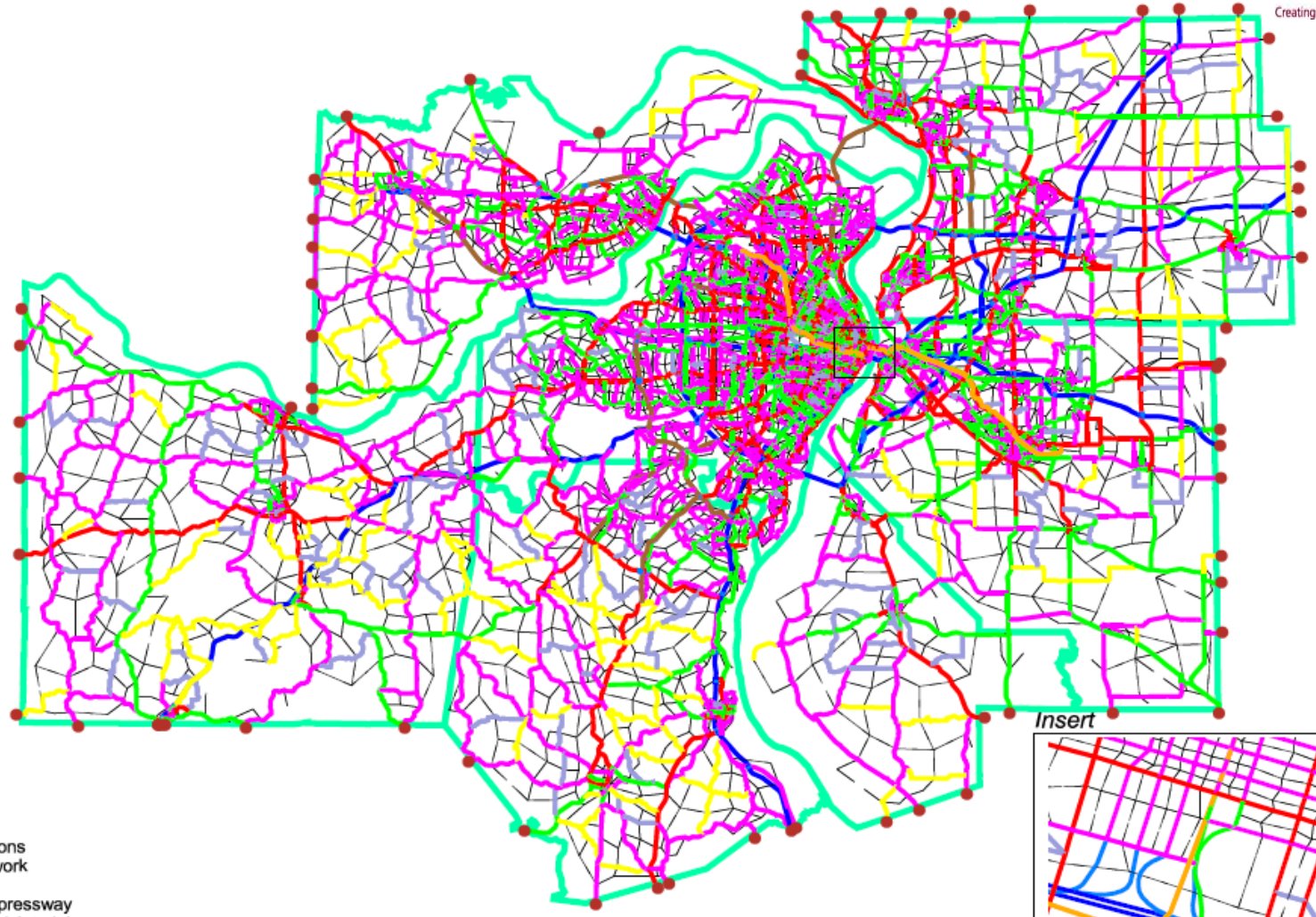
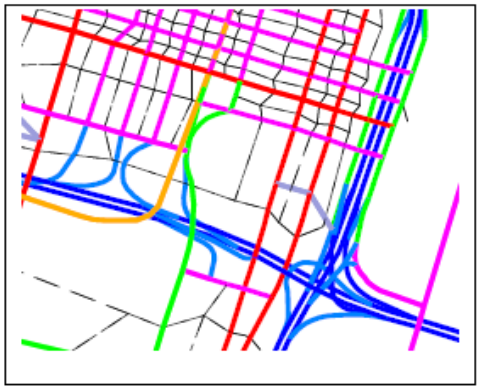
Creating Solutions Across Jurisdictional Boundaries



Insert



External Stations
2002 Highway Network
Interstate
Restricted Expressway
Other Principal Arterial
Minor Arterial
Major Collector
Minor Collector
Ramp
Local Road
Metrolink
Centroid Connector
County Boundary

N

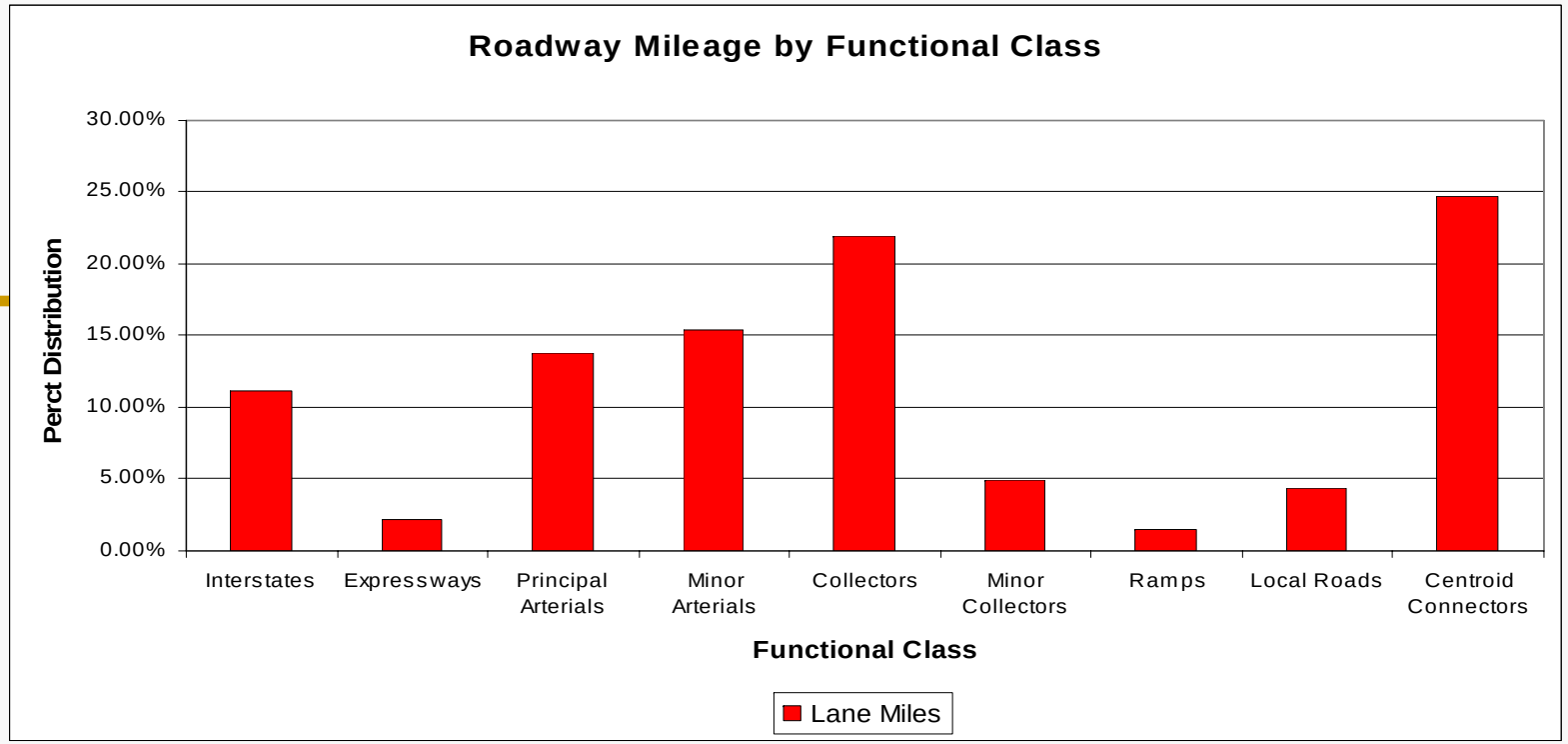
3 0 3 6 Miles

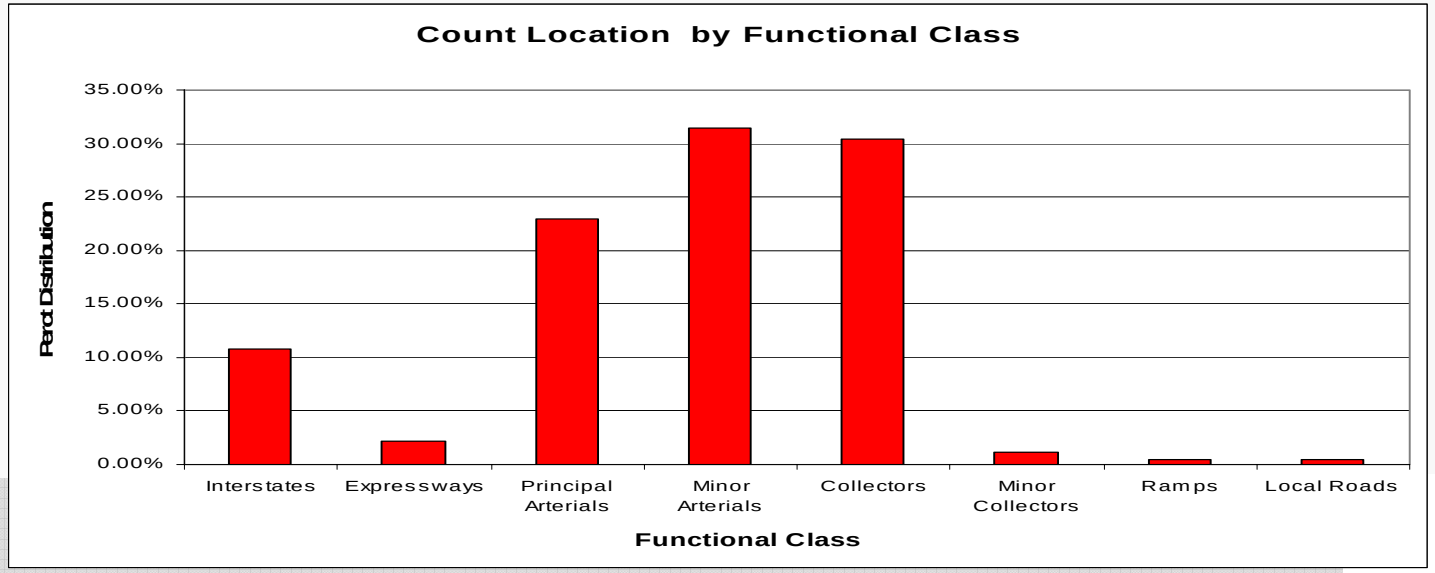
Highway Network: Statistics

- 25,565 Links (Plus 14,916 C . C)
  - 14,352 Non Directional Links (Plus 7,464 C.C)
- 2,527 Centroids and 68 External Stations
  - 5.75 Centroid Connectors (C.C) per TAZ
- Roadway Mileage
  - 8,144 Center Line Miles
  - 18,509 Lane Miles
- 1,974 Count Location
  - 14% of the Roadway Link have Counts

Network Statistics: Contd.

- Average Free Flow Speed 39 mph
- Two Major Sub-Regional Movements





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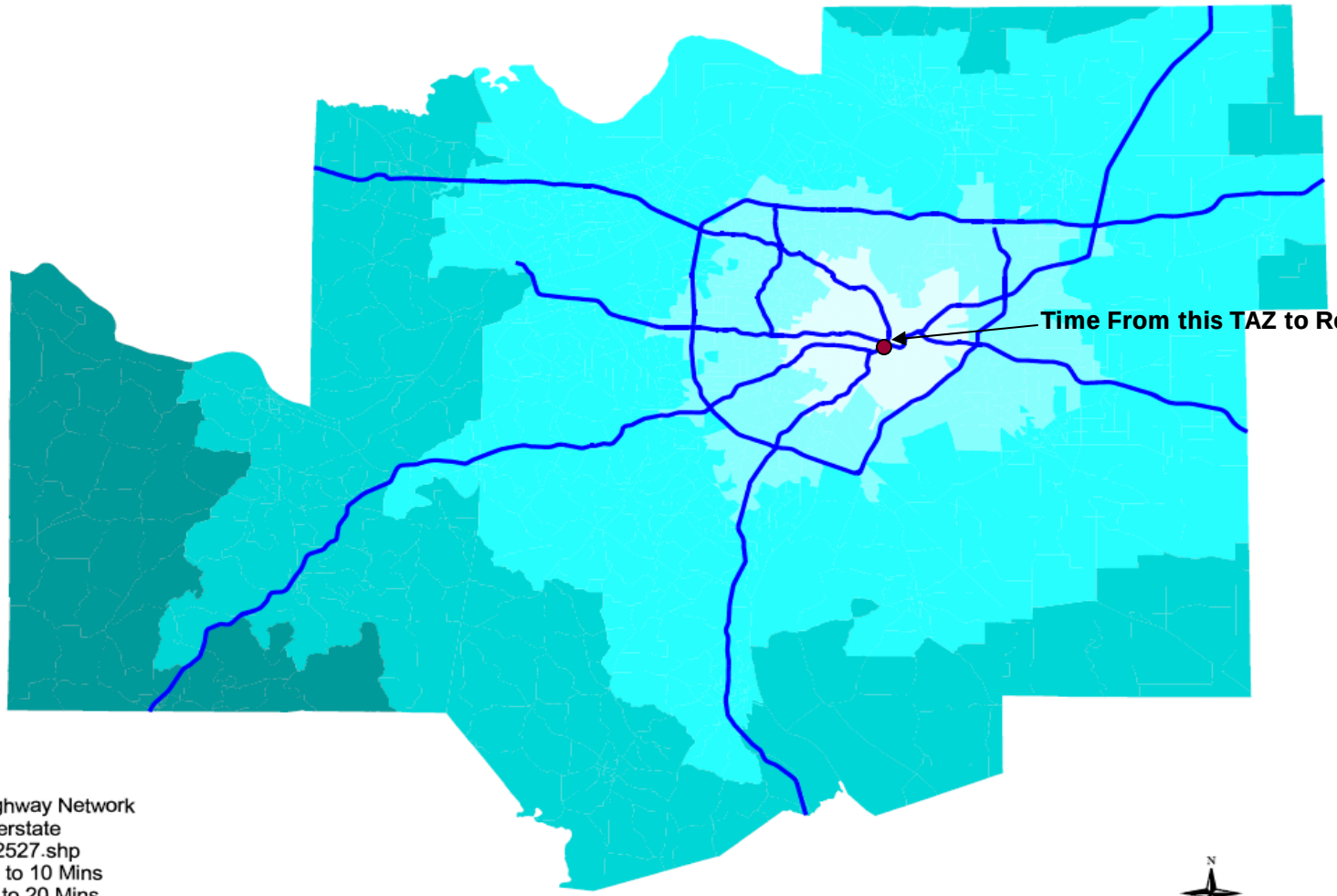
Highway Network: Development

- Network Data Base
  - Based on Tiger Shape Files
  - Model Uses *.Net Format (CUBE)
  - Maintain Network in both Formats
    - Can Import/Export into Shape Files
- Network Checks
  - Representation and Connectivity
  - Network Input Variables
    - Collected Variables
    - Estimated Variables

St. Louis MO-IL 2002 Free Flow Time Contour



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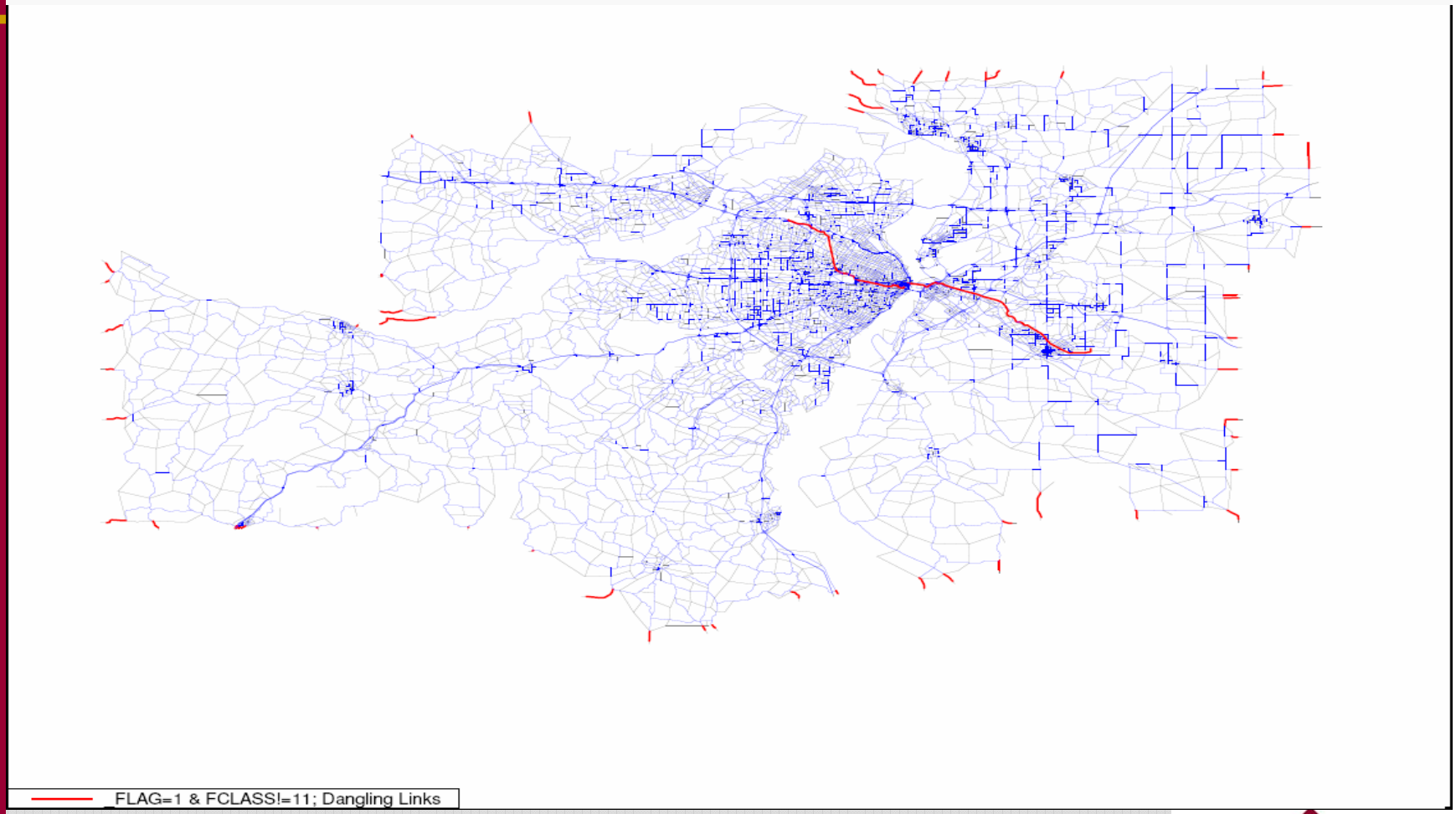
Network Checks: Dangling Links



Highway Network: Input Variable

- Collected Variables
  - Posted Speed Limit (maximum 70 mph)
  - Number of Lanes
  - Distance
  - Turn Prohibitions
  - AADT

Highway Network: Input Variable

- Estimated Variables
  - Centroid Connector Distance
    - Local Roadway Grids- Source Data
    - Equal C.C Distance within a TAZ
      - ✓ Network Loading
      - ✓ Local Roadway VMT
        - ✓ On an Average One Half to One Third of the Distance to the Centroid
- Major Issue:
  - Tedious Manual Process

St. Louis MO-IL: 2002 Highway Network

Centroid Connectors are based on the local road way grid inside the TAZ.
All Centroid Connectors within a TAZ have the same link distance.

2002 Highway Network
- Interstate
- Restricted Expressway
- Other Principal Arterial
- Minor Arterial
- Major Collector
- Minor Collector
- Ramp
- Local Road
- Metrolink
- Centroid Connector
- Local Roads Grid
- TAZ Boundary

N

3 0 3 6 Miles

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Estimated Variable Contd. Lane Capacity

- Lane Capacity (Hourly and Period)
  - Changes with Change in Land-use
  - Level of Service E
  - Based on HCM 2000 Design Criteria
  - Combination of Network Variables
    - Roadway Functional Class, Area Type
    - Posted Speed, Number of Lanes

Basic Criteria for Capacity Calculation: Example Table

Fclass		Area Type	Posted Speed		Total Lane	Capacity (Volume/Hr)	Remarks
			Lower Limit	Upper Limit			
3	**Principle Arterial**	**Rural**			**>2**	**1400**	**Multi lane Hwy**
3	,,	Rural			= 2	1200	Two Lane Two Way
3	**,,**	**CBD**	**45**			**1000**	
3	,,	Other Urban	45			1300	
3	,,	CBD	40	45		900	
3	,,	Other Urban	40	45		1200	
3	,,	CBD	30	40		800	
3	,,	Other Urban	30	40		1100	
3	,,	CBD		30		700	
3	,,	Other Urban		30		1000	

Note: A combination of Variables are used to estimate the lane capacity

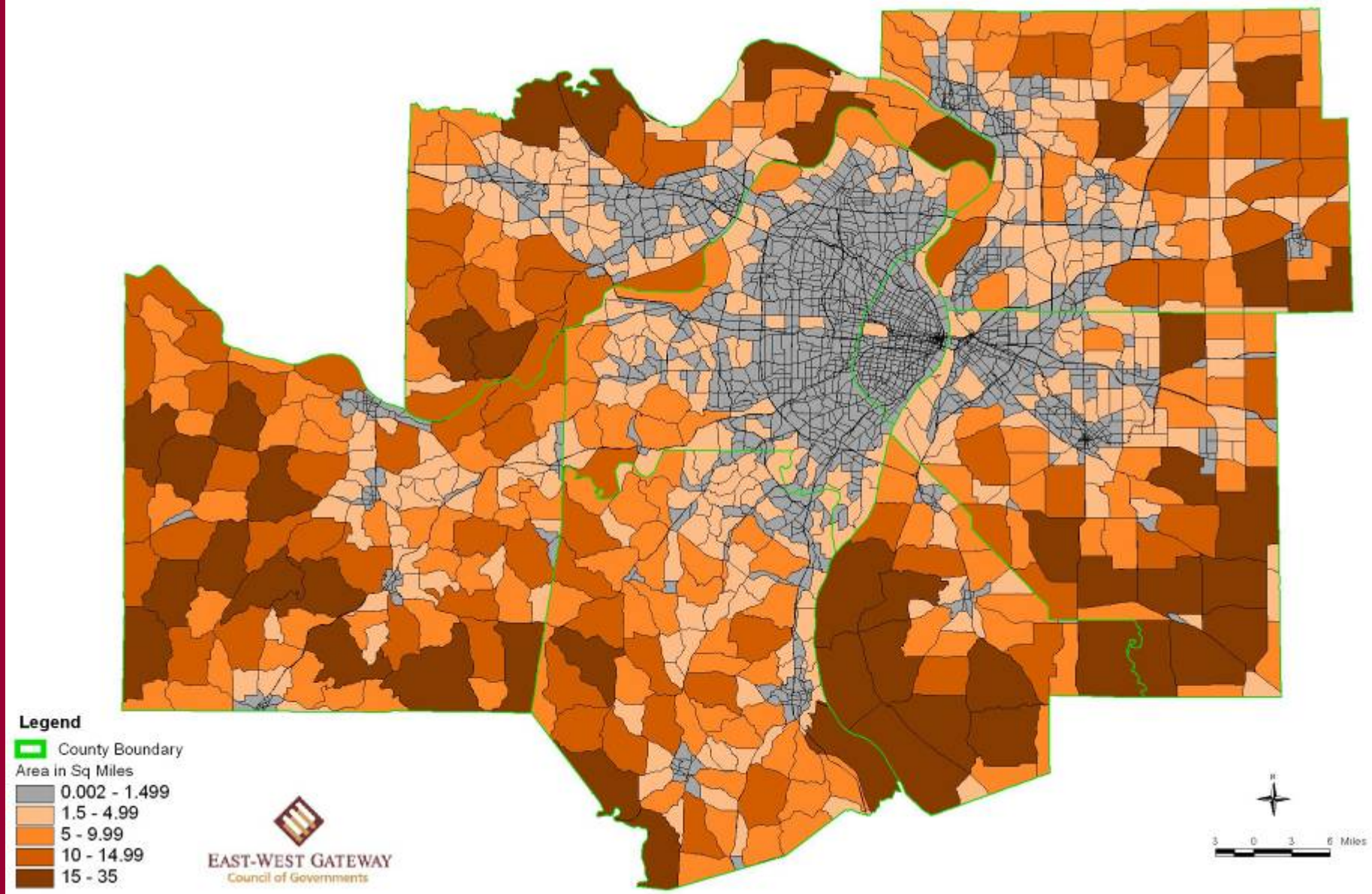
Lane Capacity: Peak Period

- Peak Period Capacity
  - ➢Based on HIS “Time in Motion” Duration
  - ➢Replicates Peak Hour Congestion for the Peak Period
  - ➢Adjustment Factor in Assignment
- Major Issue: Bottlenecks Capacity

Example Table: Peak Period Capacity for the Intersate

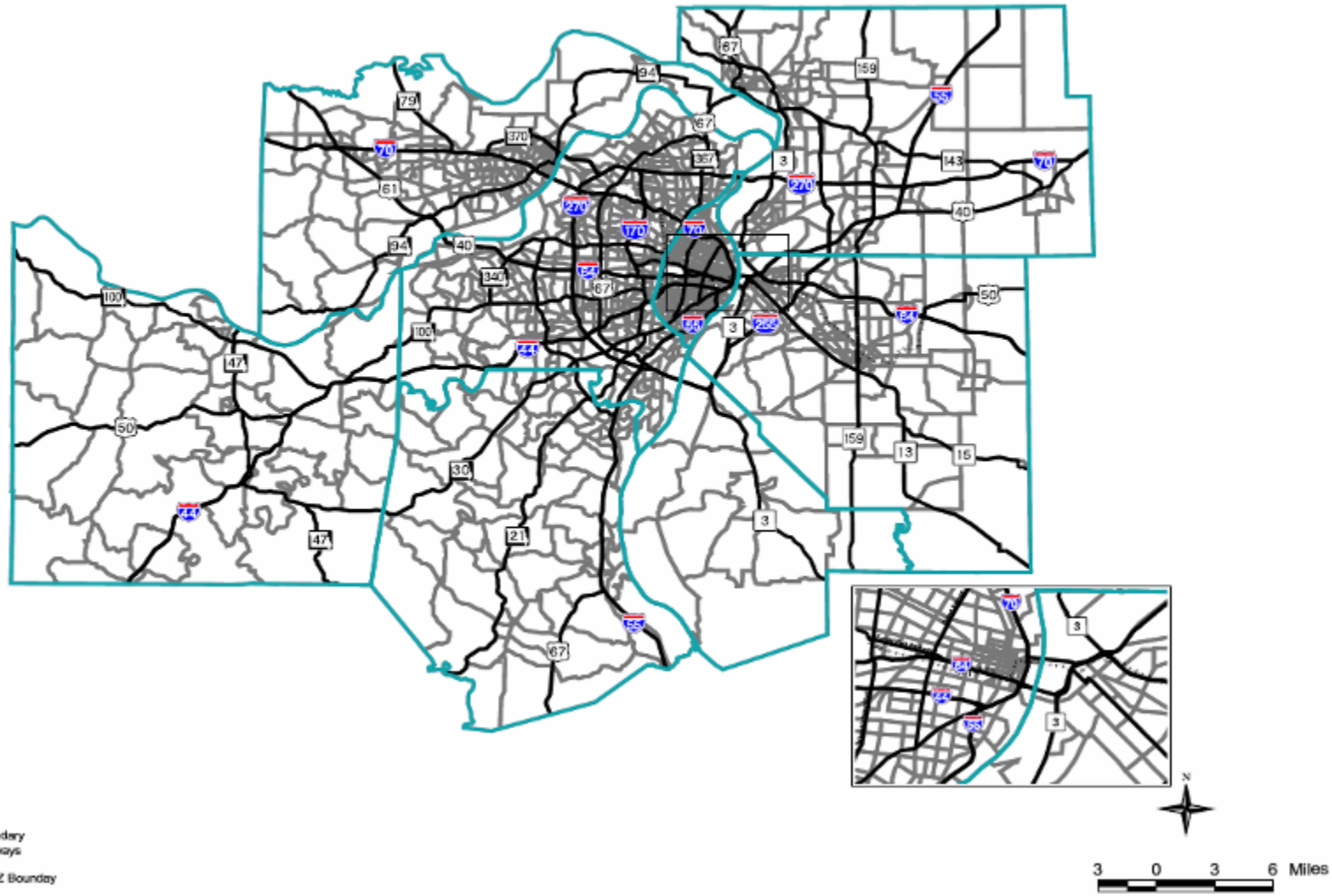
Time Period	Lane Capacity (Vehicle/ Hour)	Lane	Total Hours (Hours)	Peak Factor	Total Link Capcity (Vehicle/ Period)		Adj Ratio
					Unadjusted	Peak Period Adjusted	
Morning Peak (6 to 9 A.M.)	2,100	3	3	0.423	18,900	14,894	0.79
Mid Day (9 A.M. to 2 P.M.)	2,100	3	5	0.224	31,500	28,125	0.89
PM Peak (2 to 7 P.M.)	2,100	3	5	0.237	31,500	26,582	0.84
Night Time (7 P.M. to 6 A.M.)	2,100	3	11	0.272	69,300	23,162	0.33

Traffic Analysis Zones



St. Louis MO-IL: Previous Transportation Analysis Zone

Traffic Analysis Zones are based the Census Block Bounday, landuse of the area, roadway demarcation and access to the highway network. There are 1398 TAZs.



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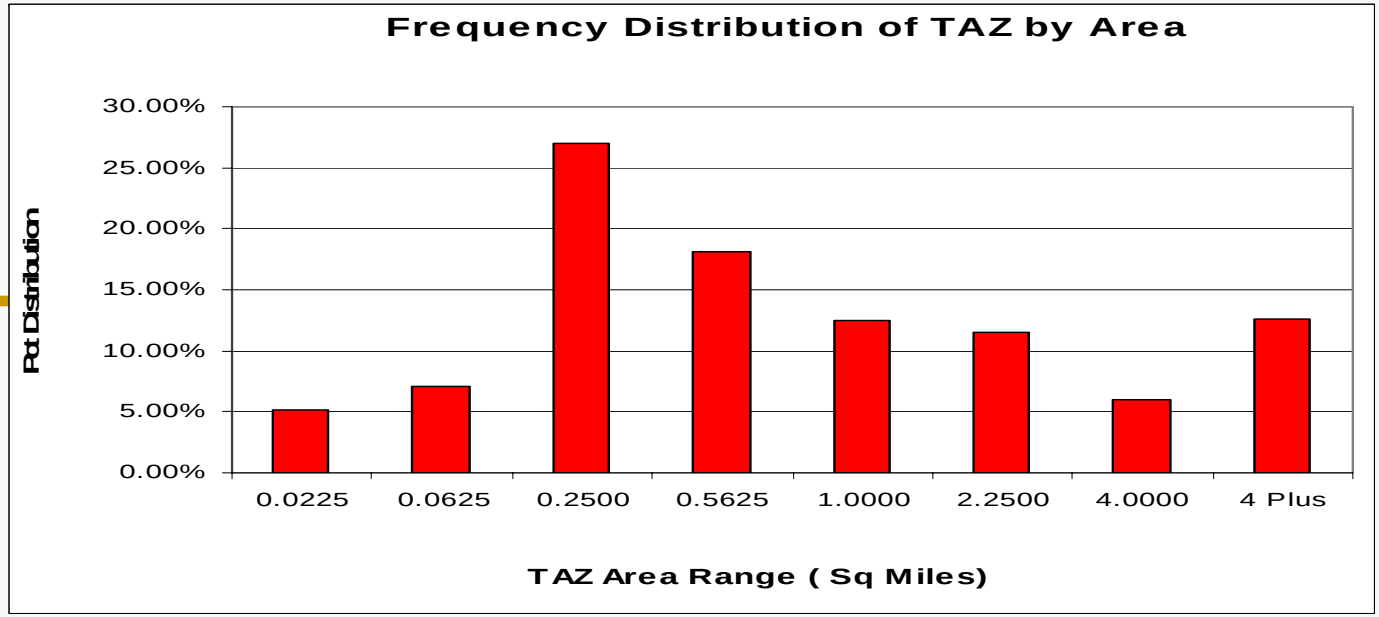
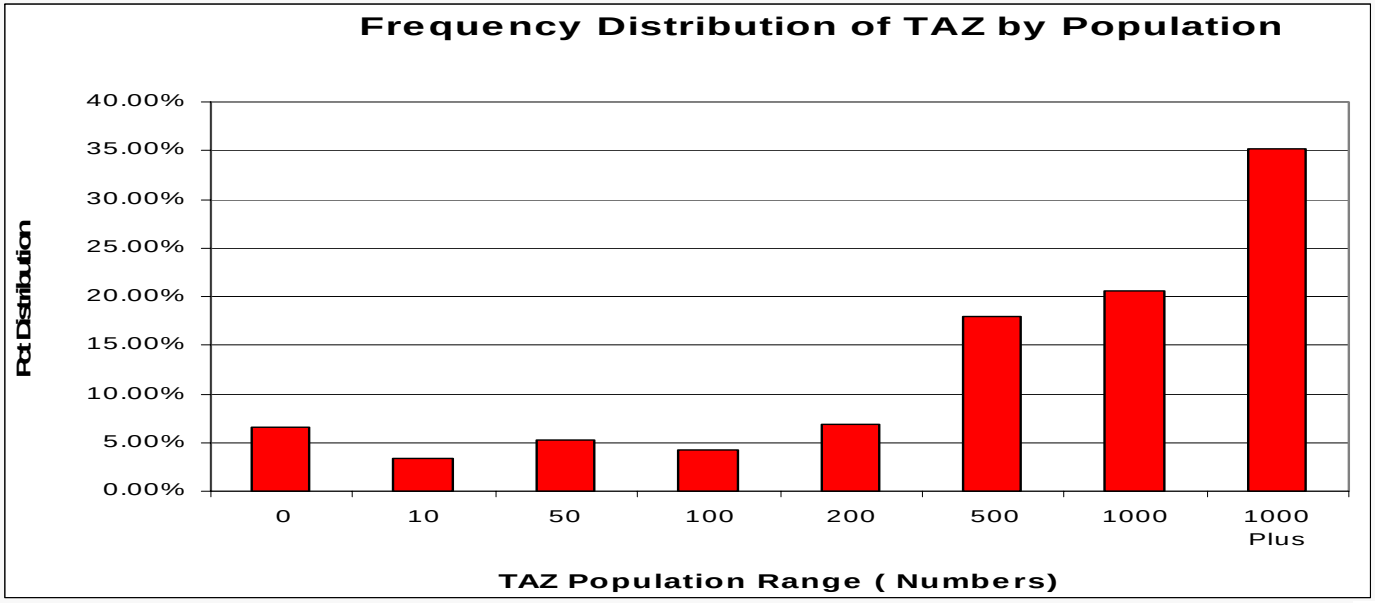
TAZ: Development

- Boundary Revision Criteria
  - Census Block Boundary
  - Land Use
  - Access to the Road
  - Roadway Network
- Major Issue: Census Data Suppression Policy
- TAZ Statistics
  - Minimum Area – 0.0025 Sq Miles
  - Maximum Area – 34.08 Sq Miles

Region	Number of TAZ	Average Area Per TAZ (Sq Miles)
MO	1710	1.62
IL	817	2.21
Regional	2527	1.81





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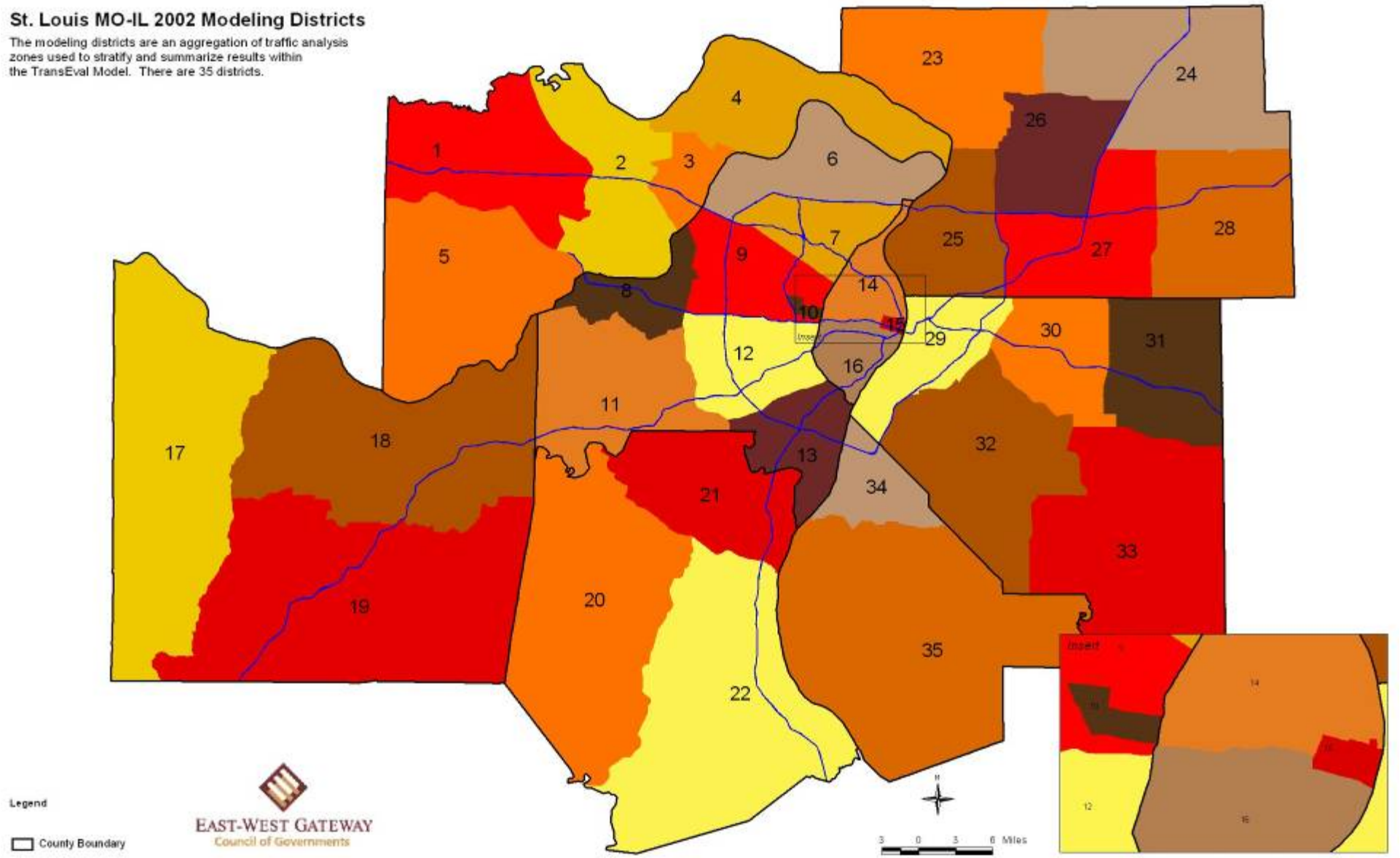
TAZ Development: Districts

- Thirty Five Districts
  - Model Output Summary
  - Reasonableness Checks Only
  - Not for Calibration

St. Louis MO-IL 2002 Modeling Districts

The modeling districts are an aggregation of traffic analysis zones used to stratify and summarize results within the TransEval Model. There are 35 districts.



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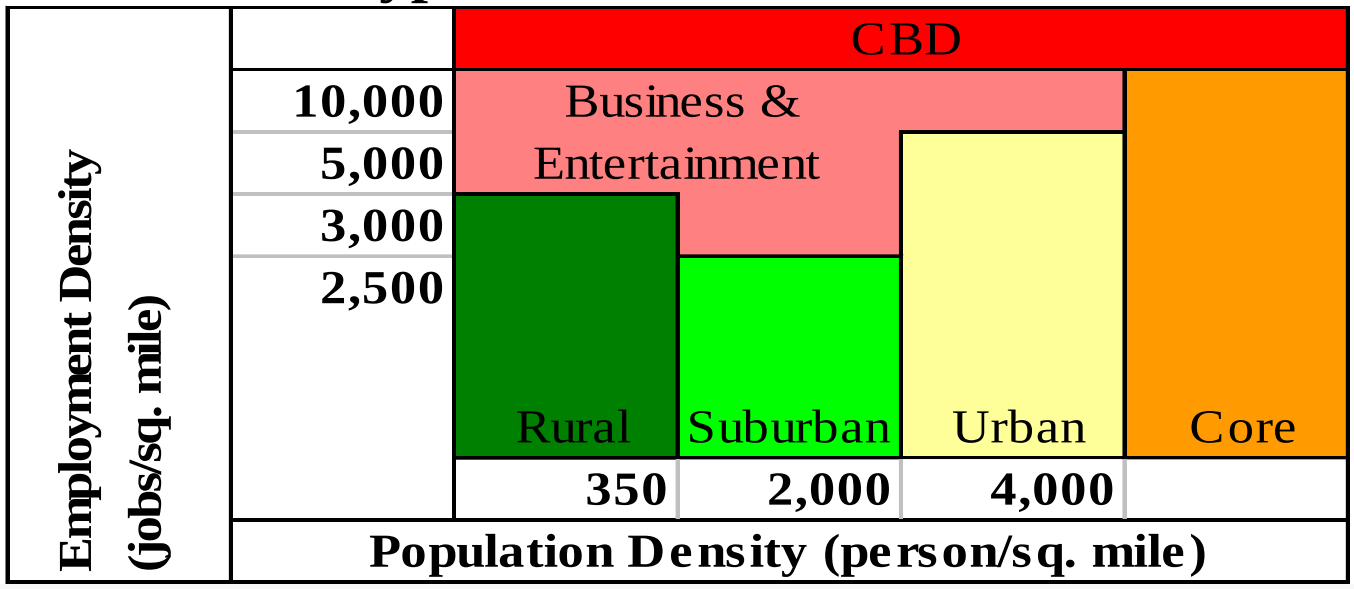
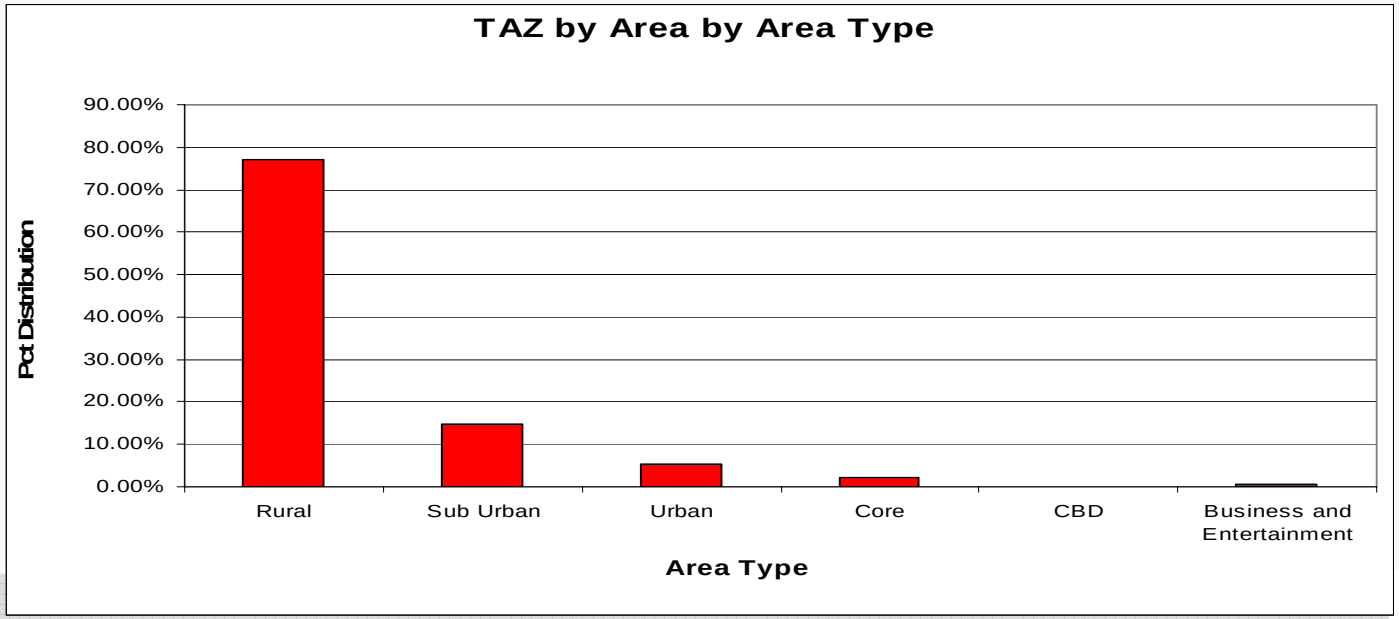
Creating Solutions Across Jurisdictional Boundaries

Model Area Type: Development

- Six Types of Area Definition
  - Rural, Suburban, Urban, Core, Business and Entertainment and CDB
- Criteria
  - Population Density
  - Employment Density
  - Considers Adjacent TAZ
  - Range Determination (Iterative Process)
- Used for Model Calibration

Area Type Definition Chart





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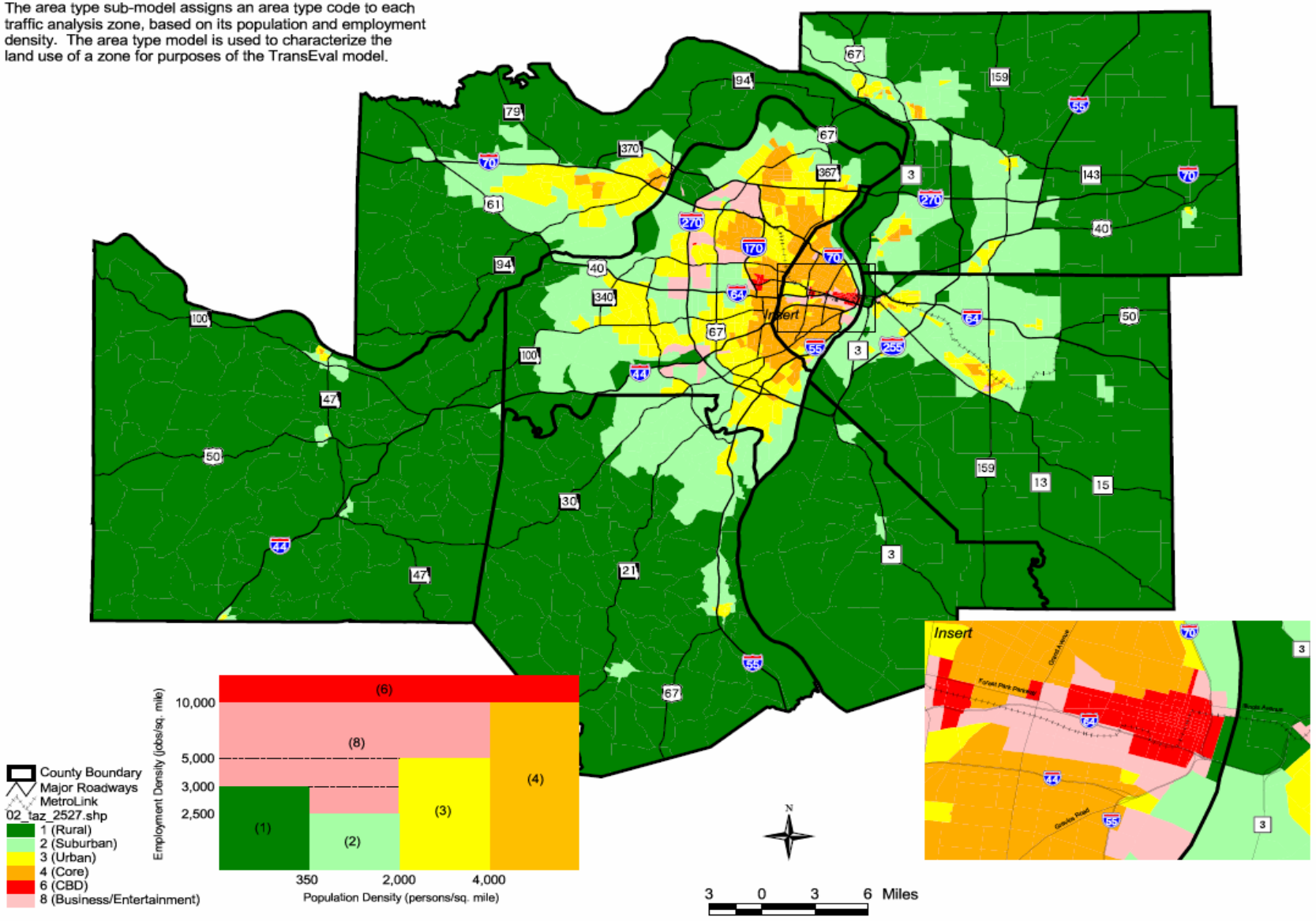
St. Louis MO-IL 2002 Model Area Types

The area type sub-model assigns an area type code to each traffic analysis zone, based on its population and employment density. The area type model is used to characterize the land use of a zone for purposes of the TransEval model.



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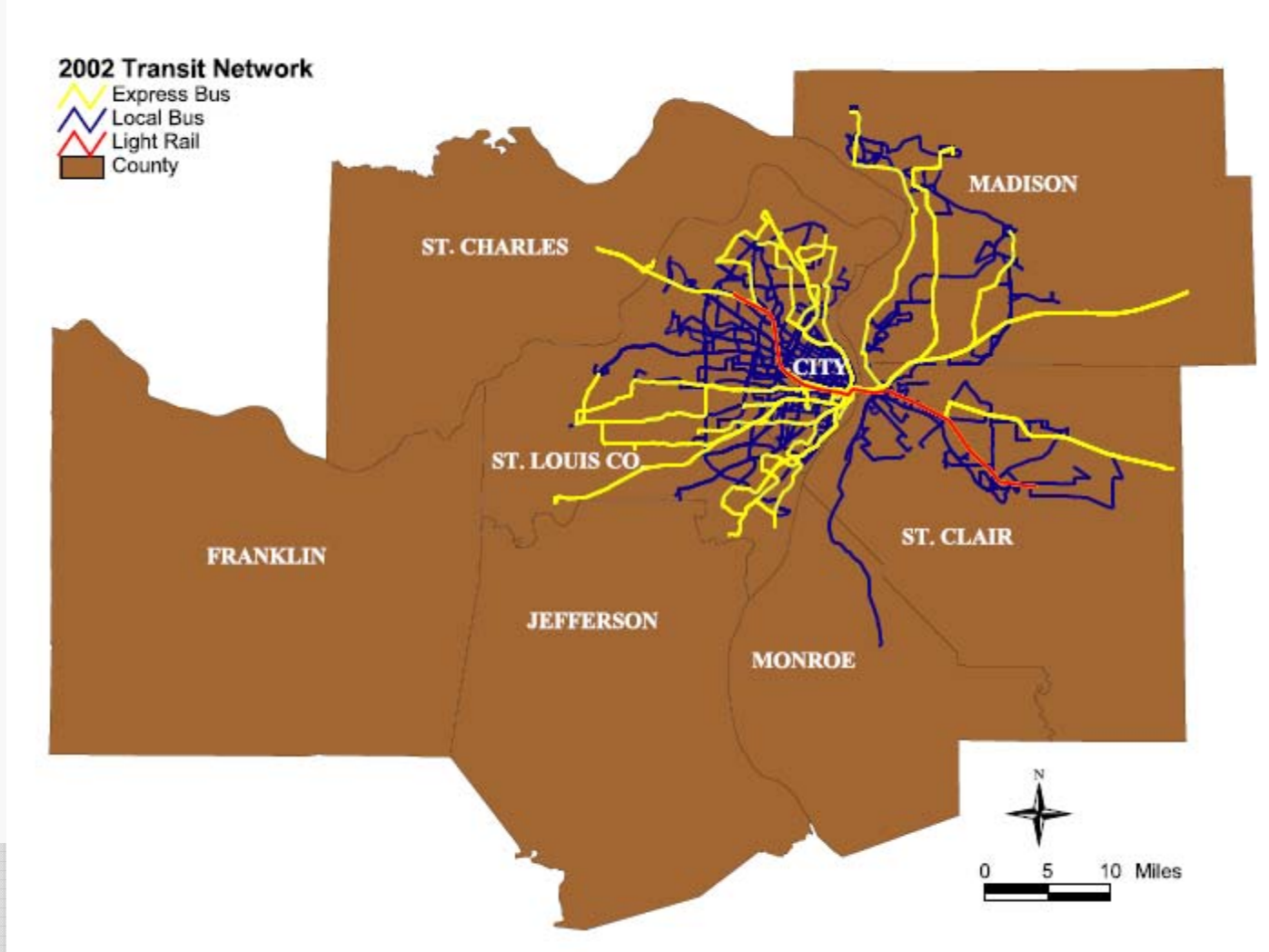
Transit Network

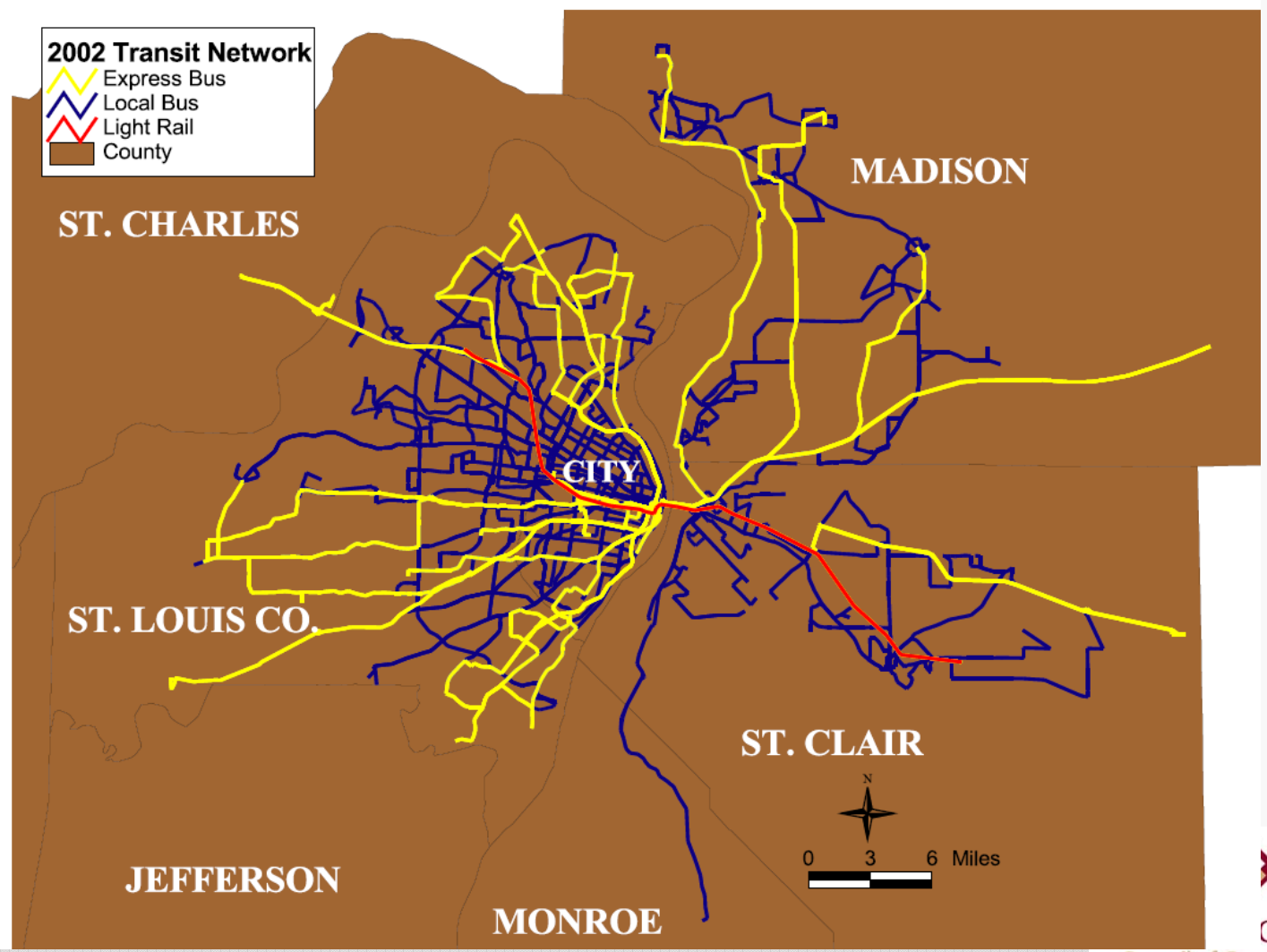


2002 Base Year Transit Network

- 82 Local Buses
- 20 Express Buses
- 1 Light Rail Line

- **Peak Period 6-9 am**
  - 268 One Way Lines Coded
- **Off Peak Period 9am-2pm**
  - 212 One Way Lines Coded

2002 Base Year Transit Network



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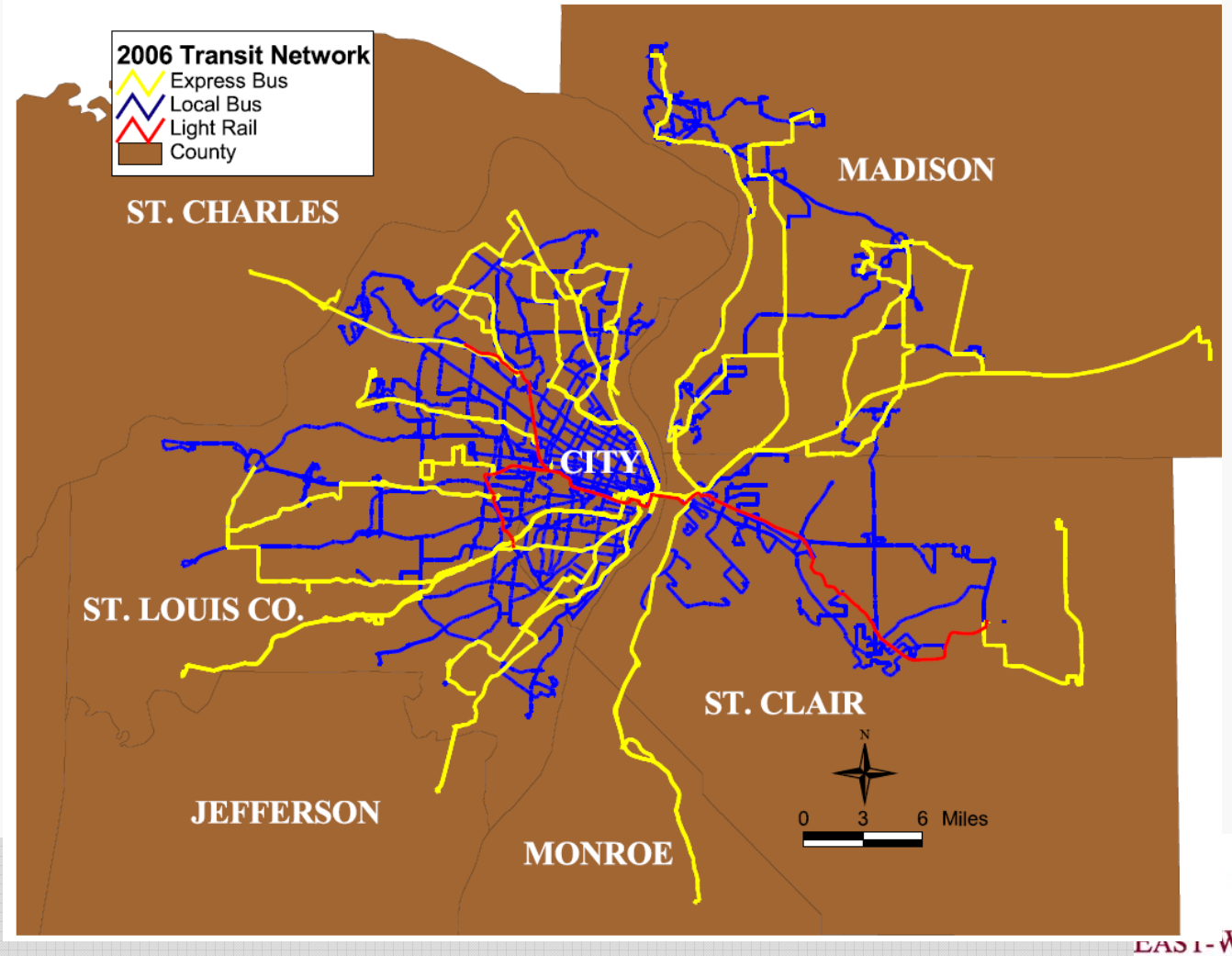
2006 And Future Year Transit Network



Transit Network

- Transit Modes
  - Local Bus
  - Express Bus
  - Light Rail
  - Future Mode Place Holder

Transit Network

- **Transit Fares**
  - **2002**
    - Local, Express, LRT =$1.25
    - Transfer= $0.25
  - **2006**
    - Local, Express =$1.75, $2.25
    - LRT=$2.00, $2.25

During Path Building, Each Path Segment is Assigned a Fare Based on Mode.

Transit Network

Transit Skims

- Grouped by Period, Access Mode, and Mode Group

Mode Groups

Local Bus

Local Bus→Express Bus

Local→Express→LRT

Transit Network

- **Bus Headway**=

$$\frac{\text{(Time Difference between First and Last Bus within Period)}}{\text{(Number of Buses-1)}}$$

- **Example**:

$$\frac{\text{3 Peak Period Buses 6, 6:30, 7:30}}{\text{(90 Minutes)}} = \text{45 min/bus}$$

(2 buses)

Transit Network

- **Bus Travel Time**
  - Transit Speed is a Function of Congested Link Speed
  - Transit Speed Functions Differ by Link Functional Class
  - Functions Account for Boarding, Alighting, and Dwell Time

Transit Network

- **Light Rail Headway 2002**
  - 7.5 Minutes Peak
  - 15 Minutes Off-Peak

- **Light Rail Travel Time & Speed**
  - Travel Time Hard Coded in Transit Line

Transit Network

- **Walk Access/Egress Support Links for Bus**
  - Generated Automatically in TRNBUILD
  - Limit of 5 Links from Each Zone to Each Mode
  - Walk Speed is Set to 3 mph

Transit Network

- **Walk Access/Egress Support Links for Bus**
  - **Walk Access Skims**
    - Walk Access and Egress Limited to 0.5 Mile
  - **Drive Access Skims**
    - Walk Egress Limited to 1 Mile

Transit Network

Walk Transfer Support Links for Bus

- Generated Automatically in TRNBUILD
- Link Distance Limited to 0.1 Mile
- Consecutive Walk Transfers Limited to 0.25 Mile or 5 min

Transit Network

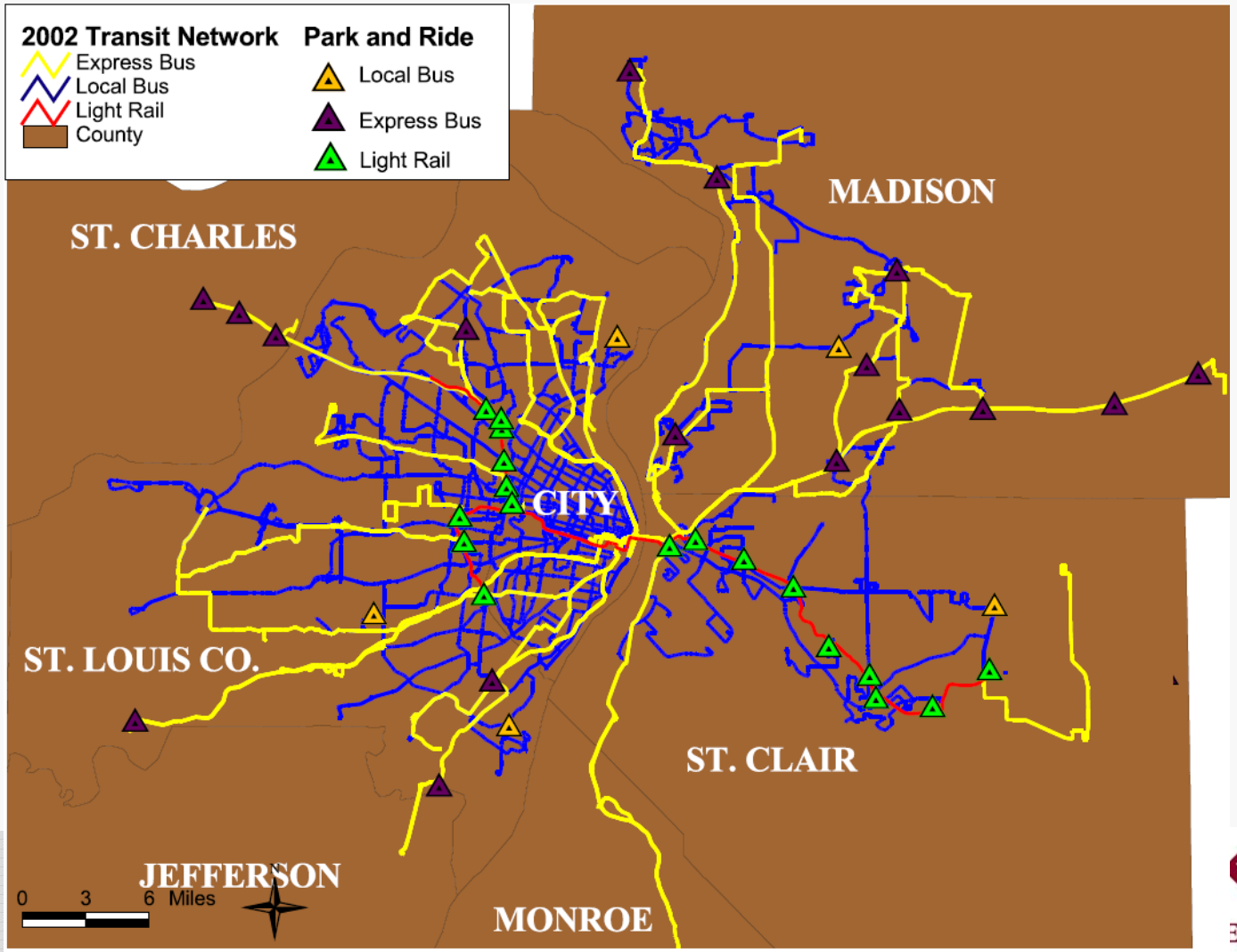
Support Links for LRT

- Read-in Text Files Contain LRT Access/Egress and Transfer Links

Transit Network

- **Park and Ride Support Links**
  - Read-in Text Files Contain PNR Nodes
  - Files are Separated by Mode
  - PNR Links Created Automatically in TRNBUILD
  - Drive Access Links are Limited to 15 Miles or 30 min

Transit Network



Transit Network

- **Modal Perceived Time Factors**
  - **Local Bus=** 1
  - **Express Bus=**0.9 for Skim or 1 Otherwise
  - **LRT=**0.9 for Skim or 1 Otherwise

Transit Network

- **Modal Perceived Time Factors**
  - Walk Access/Egress and Transfer= 2
  - Drive Access/Egress= 1

Transit Network

Wait Time= ½ The Headway of a Transit Line

Perceived Wait Time Factors

- Initial Wait Time= 1.0
- Transfer Wait Time= 3

Actual Wait Time Minimum and Maximum

- Initial Wait Time= 2-60 Min
- Transfer Wait Time= 1-60 Min

Transit Network

Transit Penalties

- Boarding Penalty= 3 min

- Transfer Penalty=
  0 min for Transfer to LRT
  6 min for Other

- Perceived Transfer Penalty Factor= 3

Transit Network

Transit Skims Output Matrix

- Total Transit IVT and IVT for Target Mode
- Initial and Transfer Wait Times
- Walk or Drive Access/Egress Time
- Transfer Time
- # of Transfers
- # of Boardings
- Total Travel Time
- Walk Distance
- Fare

Transit Network

Transit Accessibility Measures

- **Accessibility Ratio**

  Jobs/ FF Transit Time

- **Accessibility Matrix**

  Product of % of Zone within 0.25 Mile Buffer of Transit Stop for each I-J Pair

Big Picture: Validation Issues

w

Validation

- Overview of Model (this afternoon)
  - Structure, data development, estimation, calibration
  - Advanced practice trip-based model
- Frame the validation issues
- Identify
  - possible sources of problems
  - further investigations
  - Acceptable criteria
  - adjustments – either model and/or data

Two Major Validation Issues

- Highway Volume-Count Validation
  - Interstate Crossings – model high
  - Freeways
    - Generally somewhat low
    - Localized sections big discrepancies (I-64)
- Transit Mode Choice
  - Too strong Alternative Specific Constants
    - LRT - positive
    - Bus - negative
    - HBO (Off-peak skims) largest ASCs

Validation Reporting Available

- Vehicle volumes, transit boardings, congested speeds
- Revenue VMT: average bus speed compared to reported
- RMSE's and "percent errors" by facility type
- RMSE's and "percent errors" for the 35 districts
- Screen line and cordon line "percent errors" For those links with observed speed info, compare the average model output road speeds by functional class against the observed
- Total bus revenue miles and revenue hours statistics from Metro and how the overall average speed compares with the average peak and off-peak bus speeds in your model
- Summarize regional VMT by time-of-day and facility type, and compare the distribution of VMT against the HIS data, and some other data that I will provide to you within a few days
- Regional versus observed weekday route boardings by modes=4 & 7, the RMSE's for the bus routes
- Modeled versus observed weekday rail station boardings, the RMSE for boardings.

Daily Estimated Flows

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Yr2002 Link Volumes

Facility Type	Average Volume	Count	VMT	VHT
Freeway	20,652	2,364	27,536,330	592,796
Expressway	21,551	319	3,382,173	76,474
Principal Arterial	10,640	5,170	13,304,674	423,492
Minor Arterial	4,520	6,773	7,841,290	250,379
Major Collector	1,903	9,219	5,244,126	180,553
Minor Collector	438	710	322,351	7,880
Local	703	909	317,066	11,003
Cent conn.	944	14,916	4,435,210	221,807
All	4,301	40,432	62,383,219	1,764,383

VMT/VHT by Time of Day

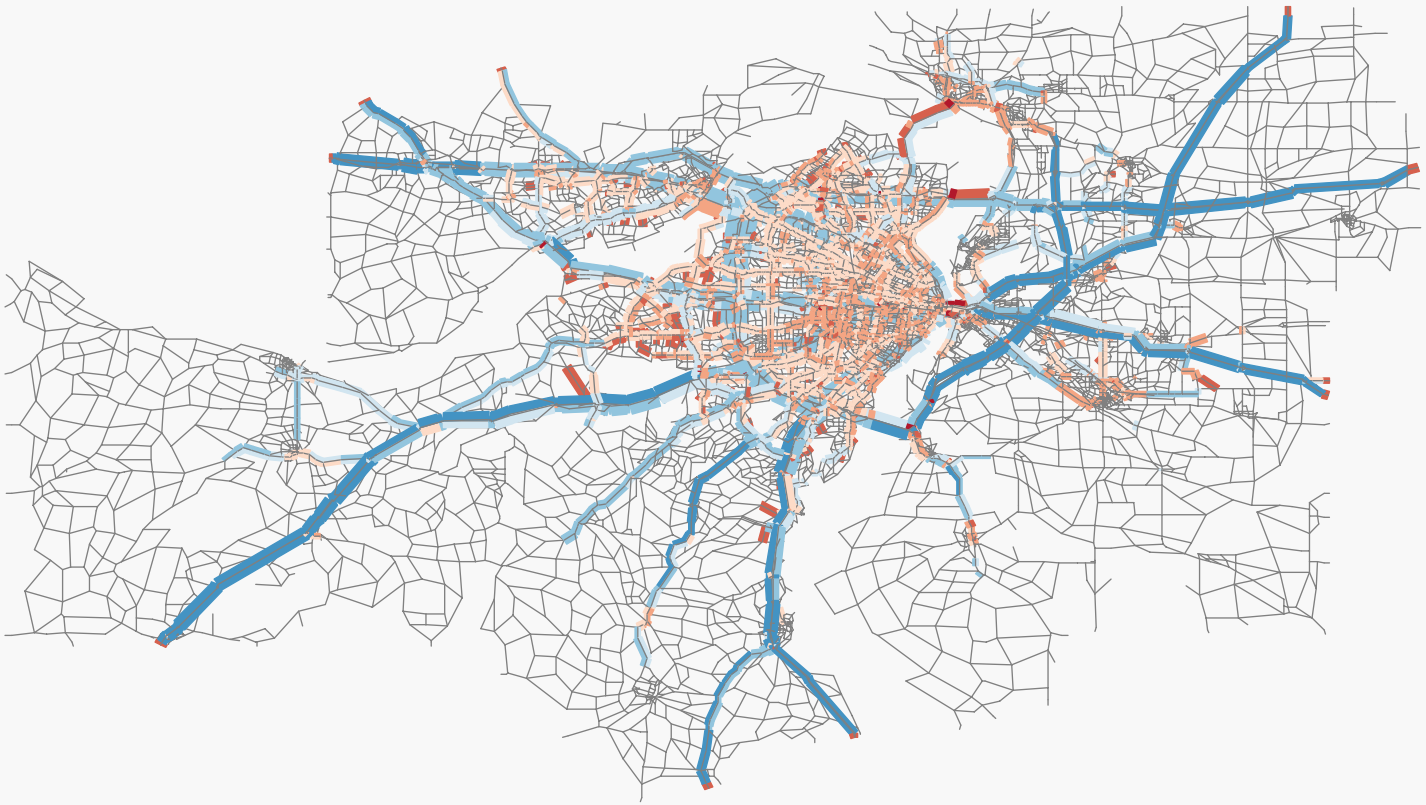
	Period			
	AM	MD	PM	NT
VMT	11,171	17,997	24,447	8,768
VHT	311	475	765	213
Speed	36	38	32	41

VMT and VHT in thousands

AM Speeds

Facility Type	FreeFlow	Congested	Pct change
Freeway	62	50	-19%
Expressway	59	53	-10%
Arterial	39	33	-15%
Collector	36	32	-11%

AM Peak Period Speeds



<10
10-20
20-30
30-40
40-50
50-60
>60

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AM Peak Period Speed

<10
10-20
20-30
30-40
40-50
50-60
>60

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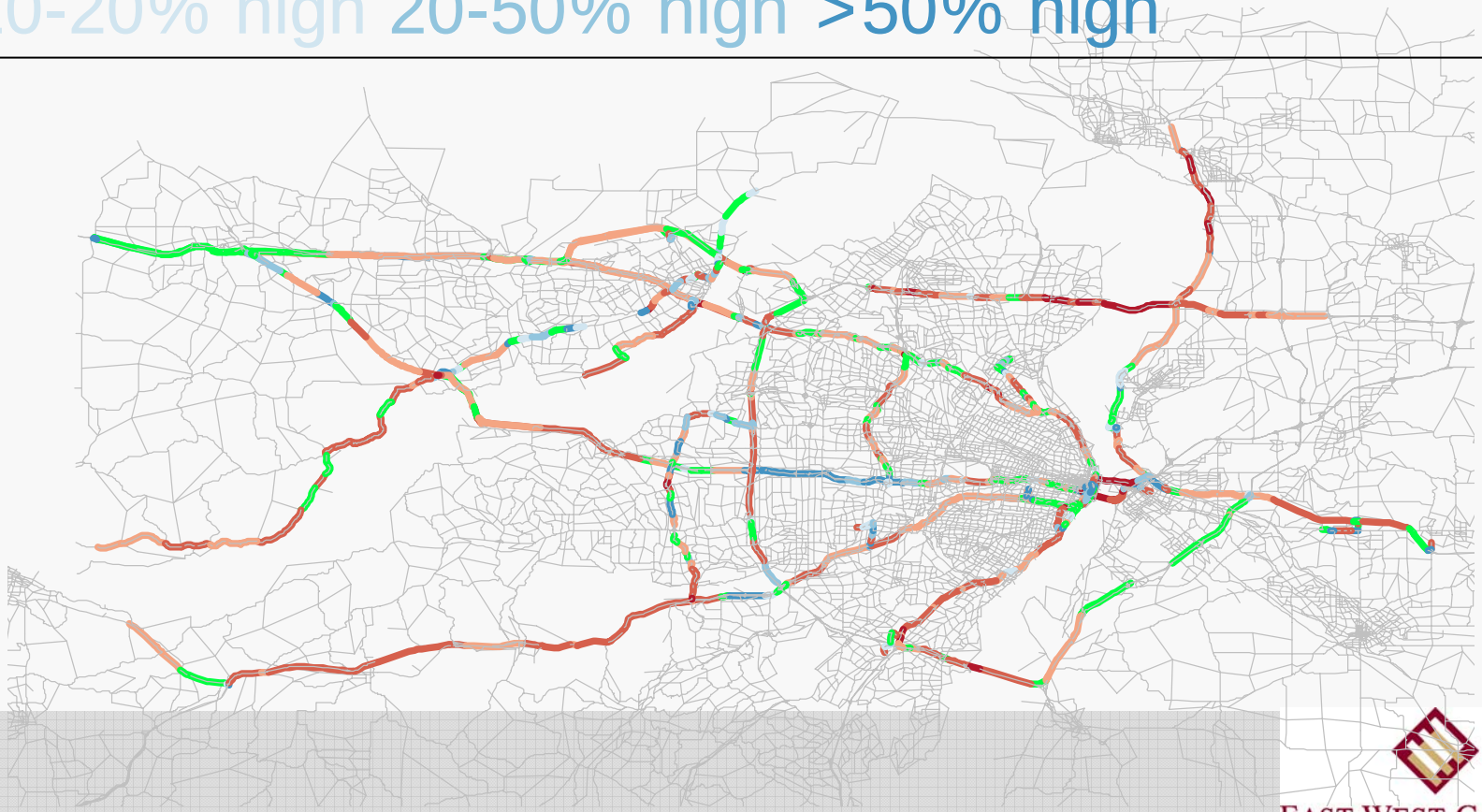
AM Peak Speeds

>50% low 50-20% low 20-10% low Within 10%

10-20% high 20-50% high >50% high



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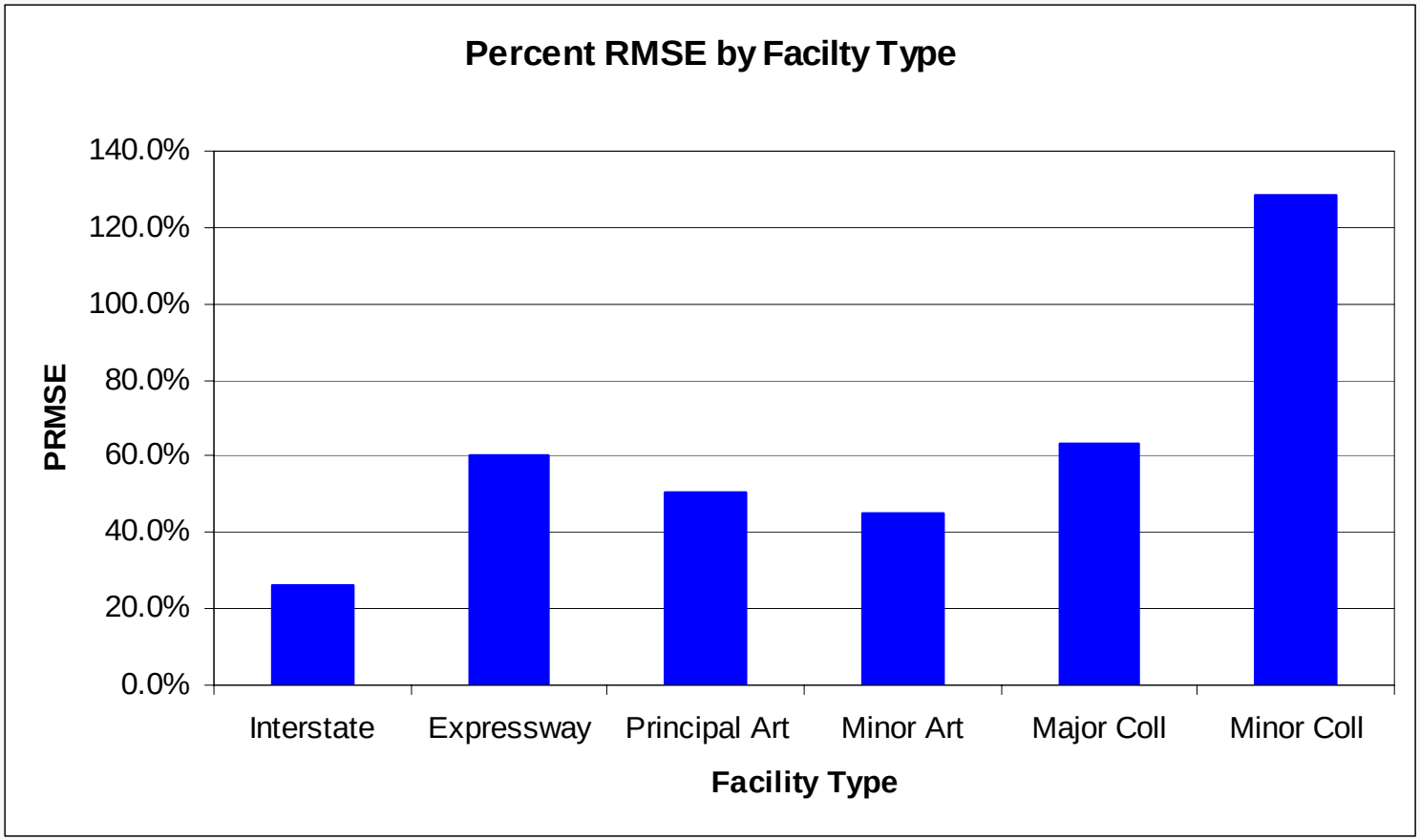
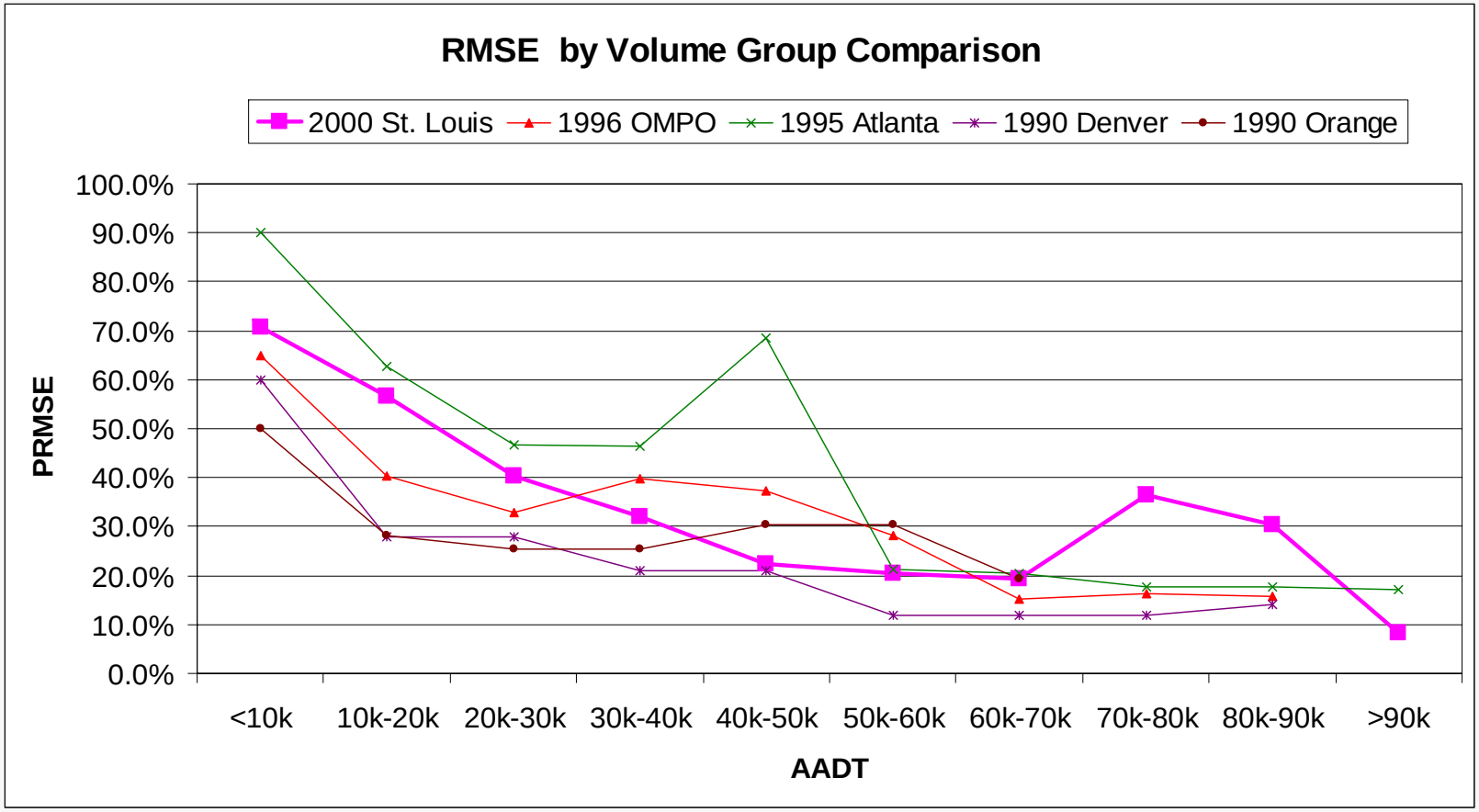
RMSE by Facility Type



Overall PRMSE = 43.2%

RMSE by Volume Group



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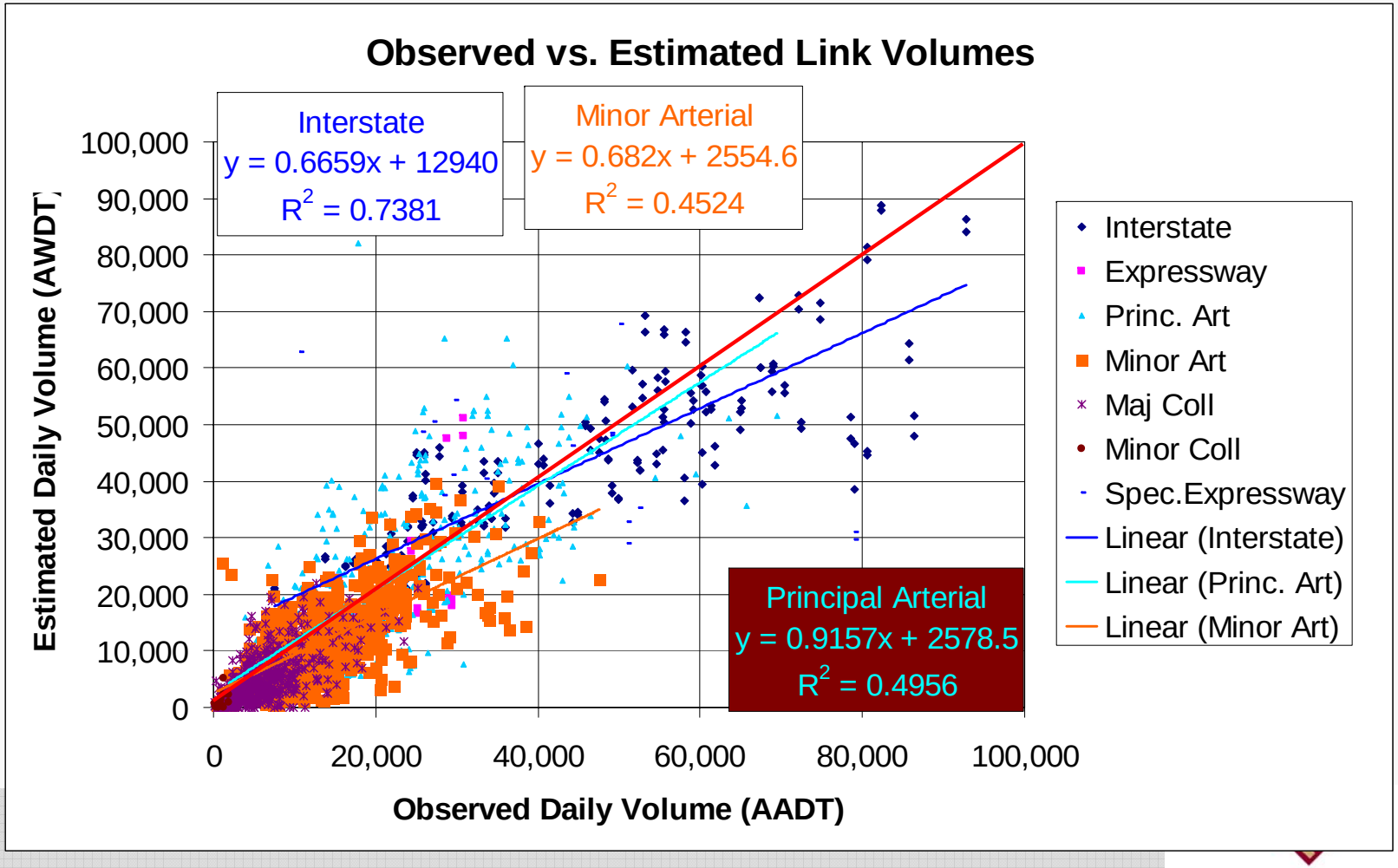
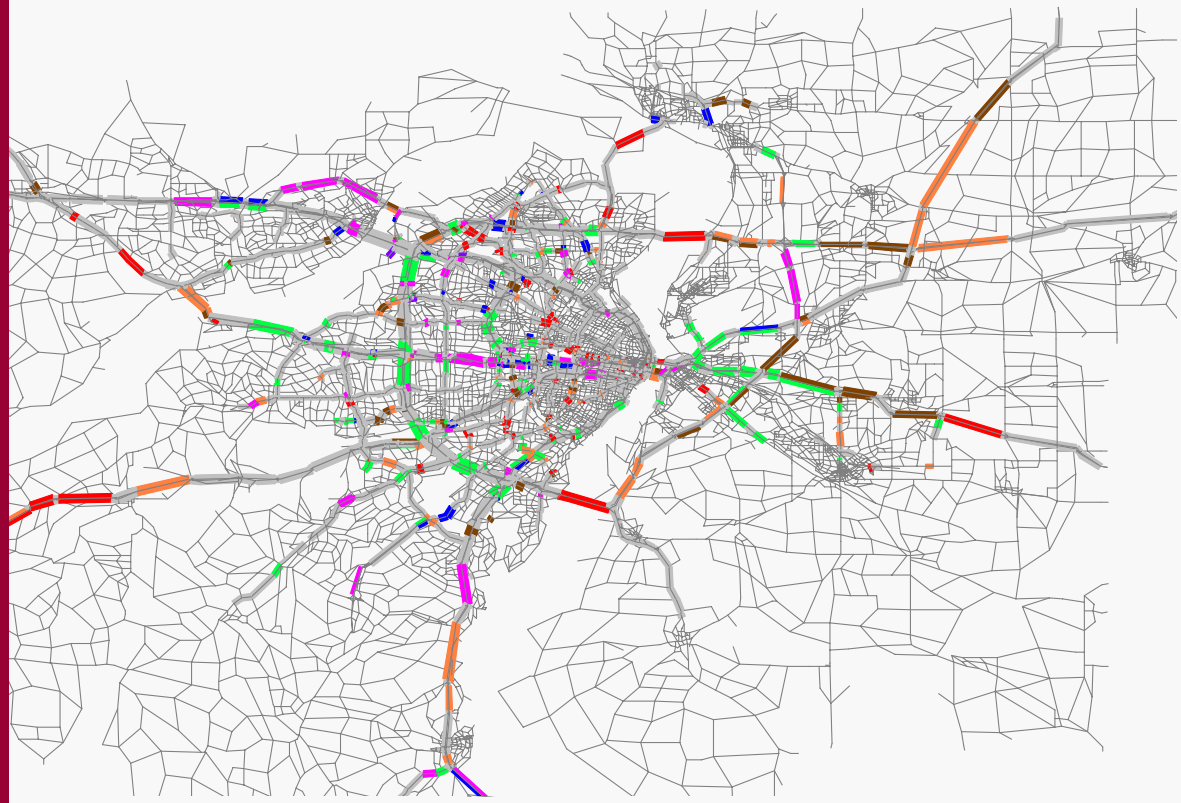
Obs vs. Est Counts



Count / Est Map



>50% low

50-20% low

20-10% low

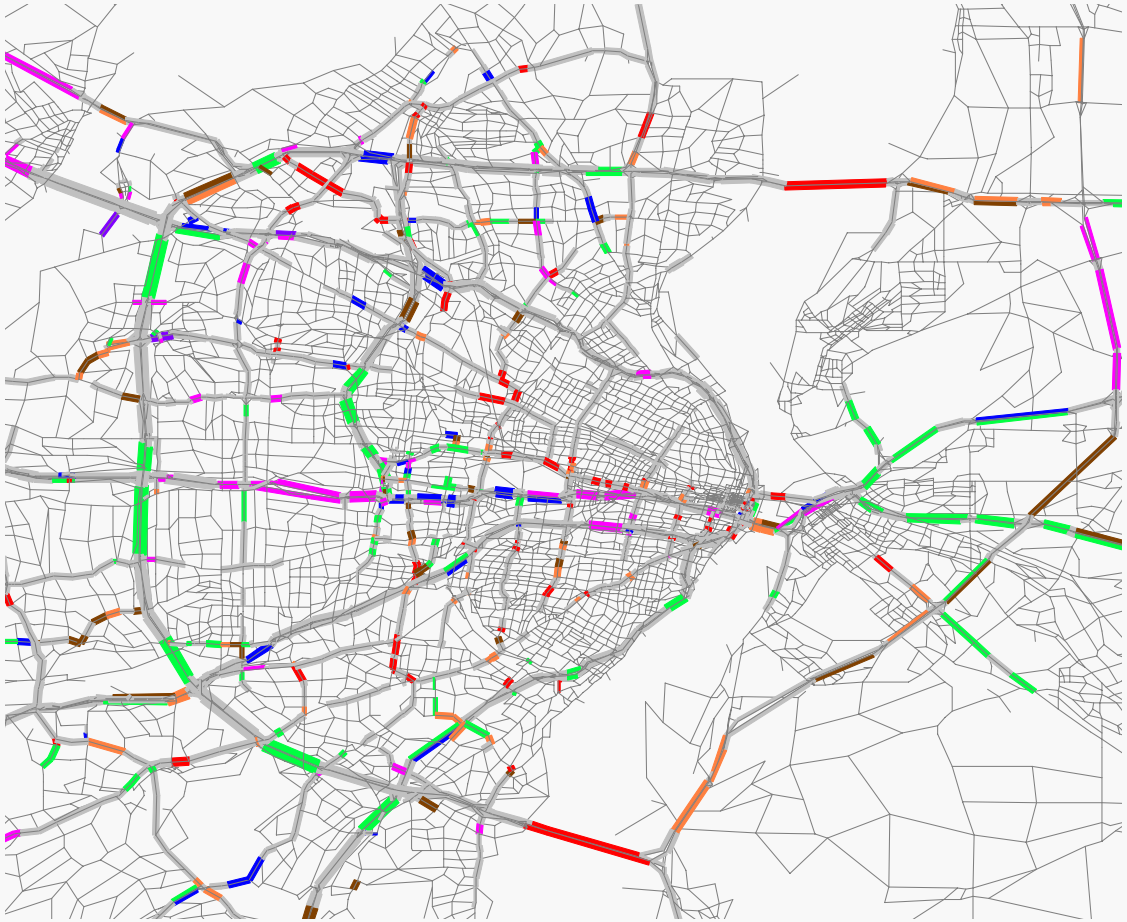
Within 10%

10-20% high

20-50% high

>50% high

Obs/Est Comparison, Core



>50% low

50-20% low

20-10% low

Within 10%

10-20% high

20-50% high

>50% high

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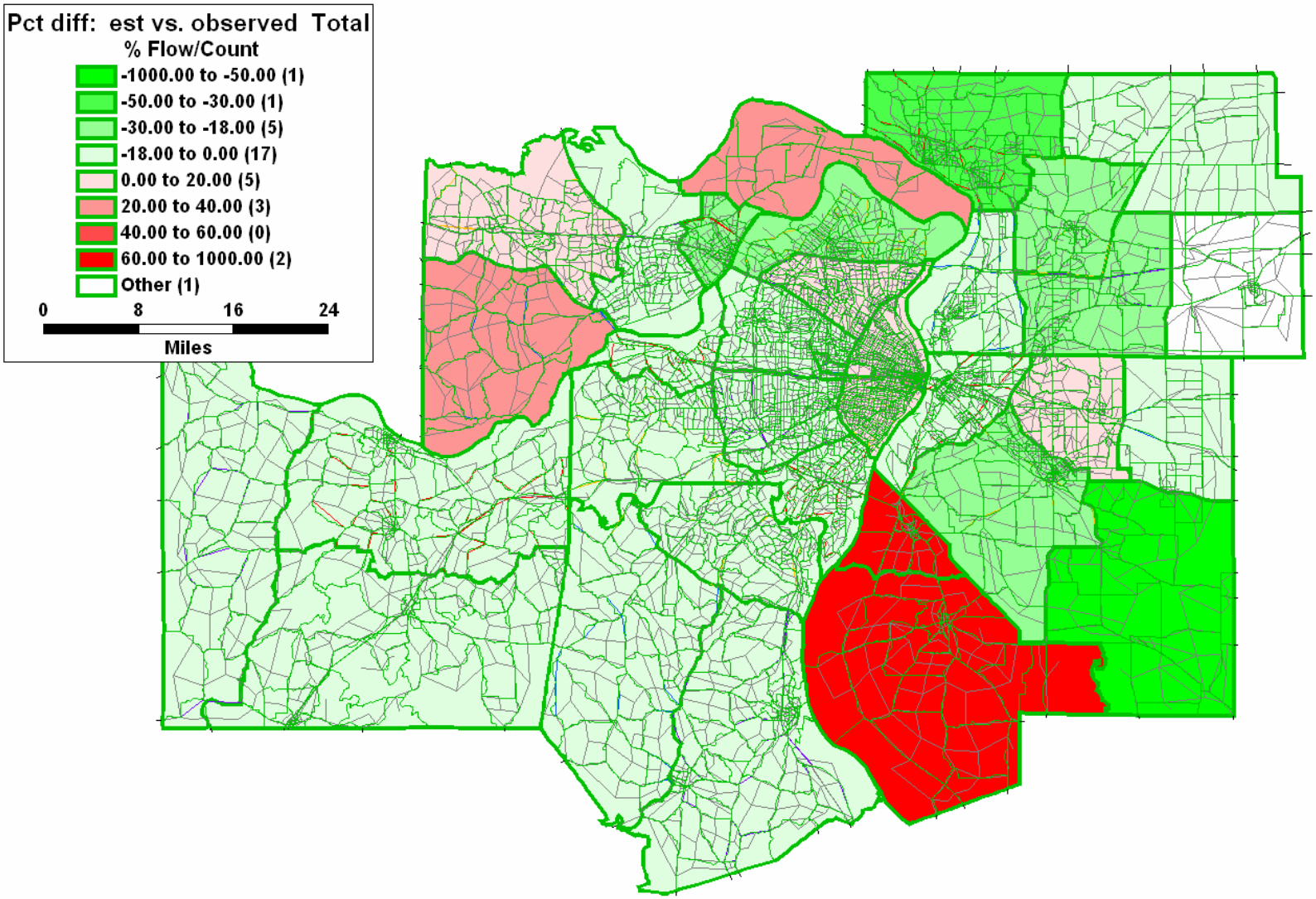
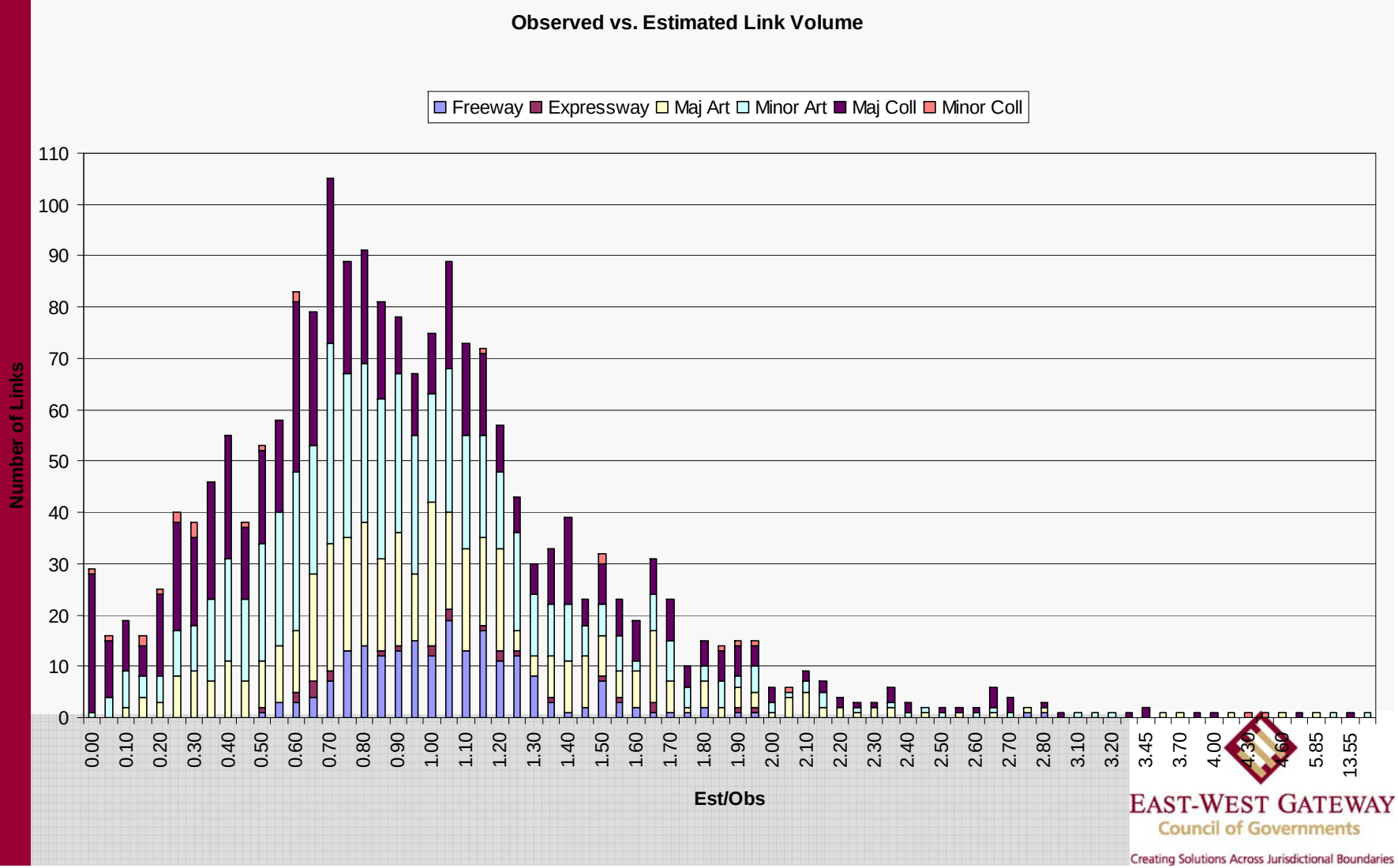
Count / Est by District



Obs / Est Link Distribution



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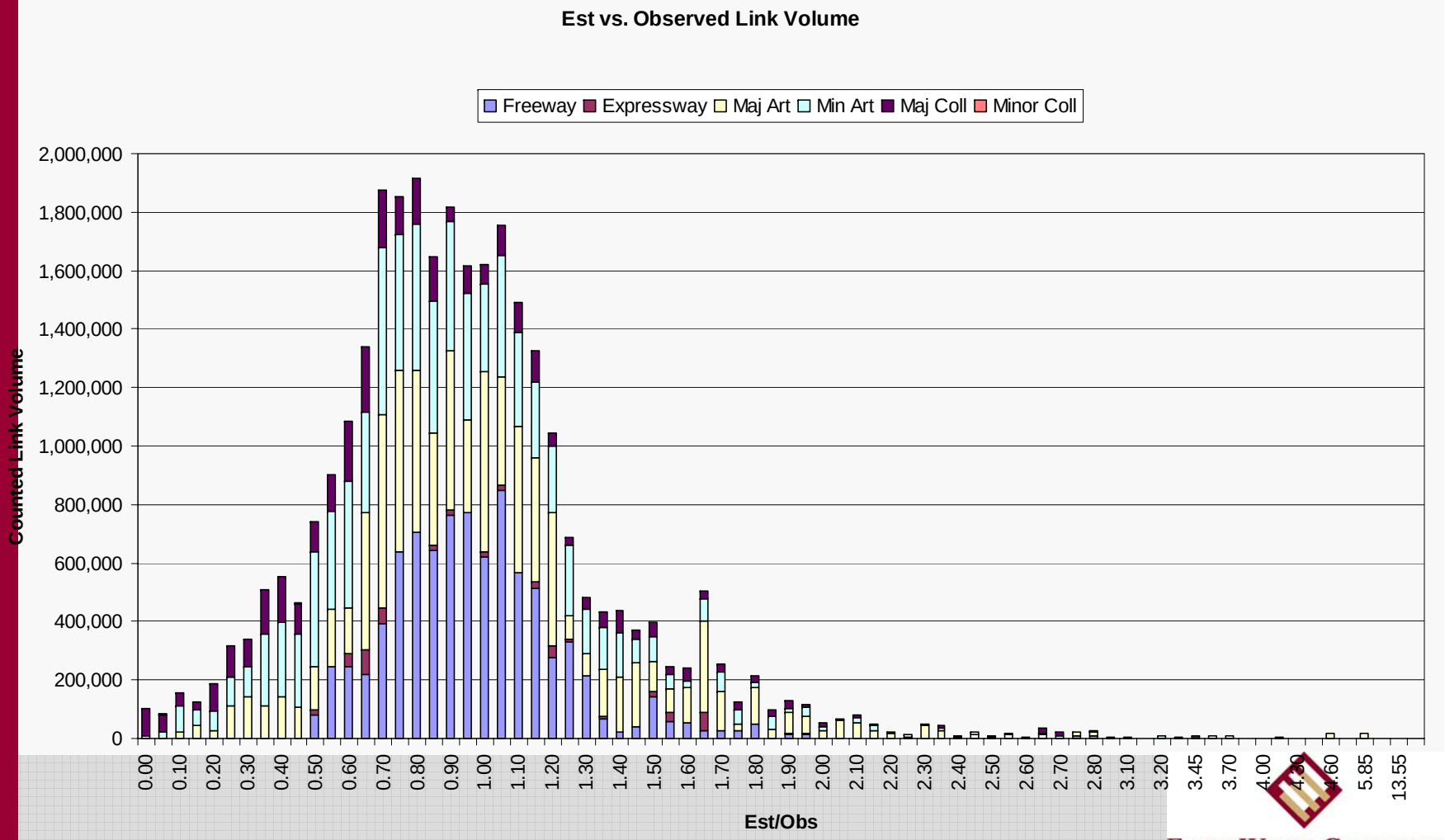
Obs/Est Link Distribution



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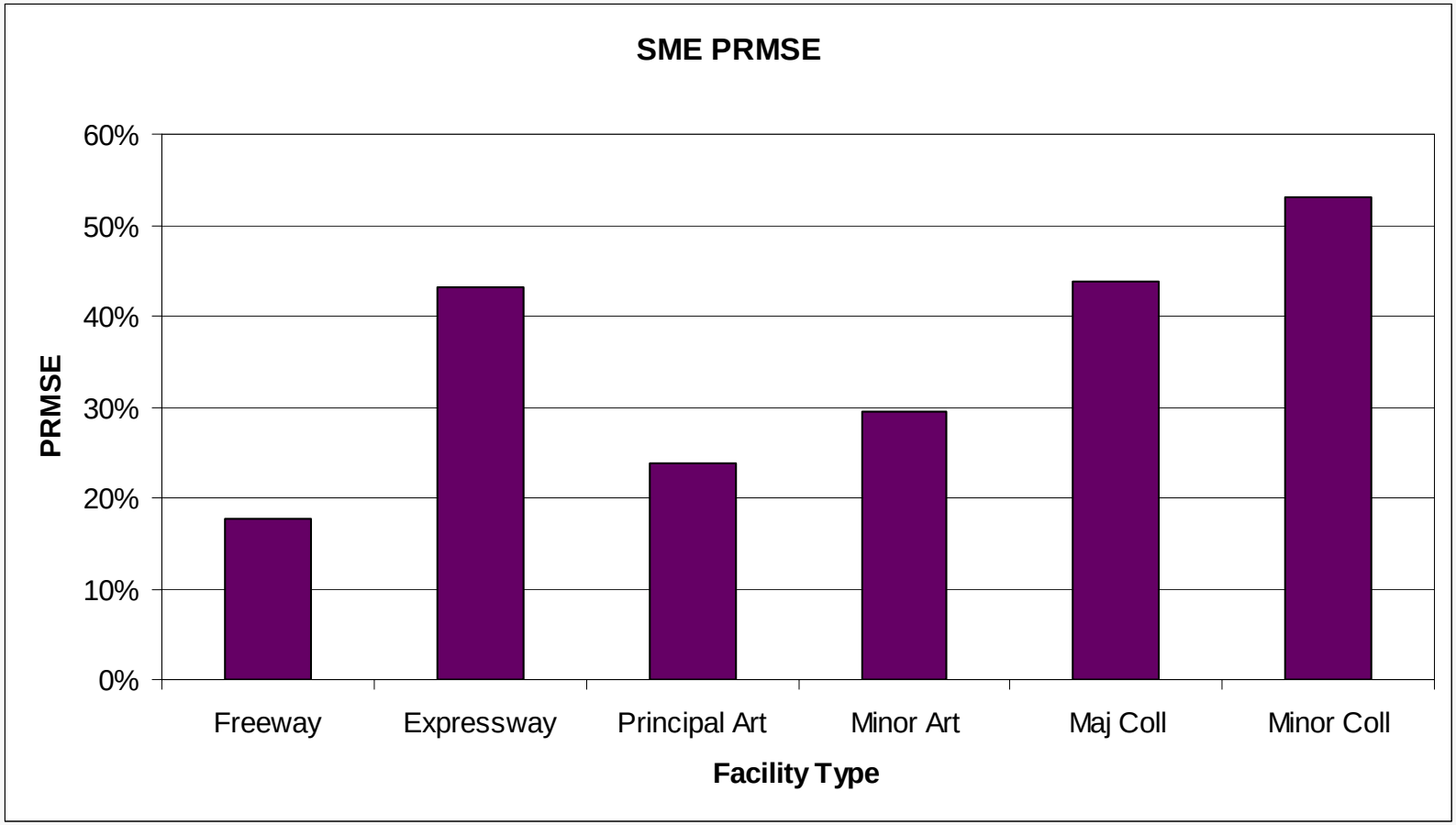
SME Test Results

- Synthetic Matrix Estimation
- Used Modeled V-T table as a base
- Used daily counts split by time, class
- 9% increase in vehicle-trips required after 10 iterations

SME PRMSE



Overall SME PRMSE=30%

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Mode Choice Calibration

- Rail Constant
  - HBW: +0.74 (25.3% Mkt Share of HBW Transit)
    - » 30 min
  - HBO: +3.05 (26.4% Mkt Share of HBO Transit)
    - » 203 min
  - NHB: +1.66 (28.8% Mkt Share of NHB Transit)
    - » 111 min
- Potential Problems:
  - Transit Rail Skims Not Competitive?
  - Off-Peak Times Not Representative?
  - Rail Access adequate?
  - Bus Times Too Fast?
  - Trip Distribution?

Target Shares (%)

Mode	Purpose		
	HBW	HBO	NHB
Auto	94.6	93.3	93.4
NM	2.1	5.9	5.8
Local	2.3	0.6	0.6
Express	0.2	--	--
Rail	0.8	0.2	0.2

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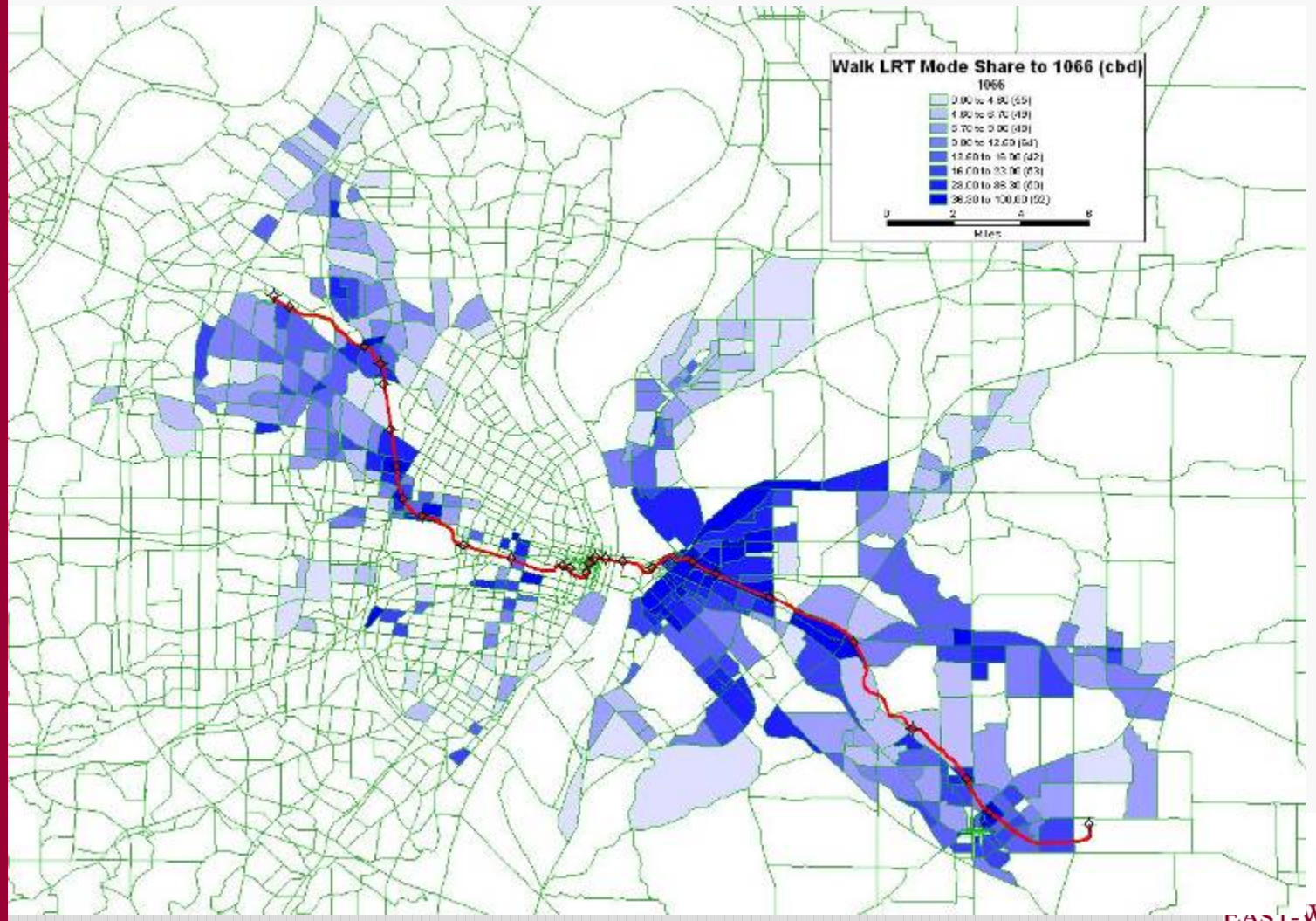
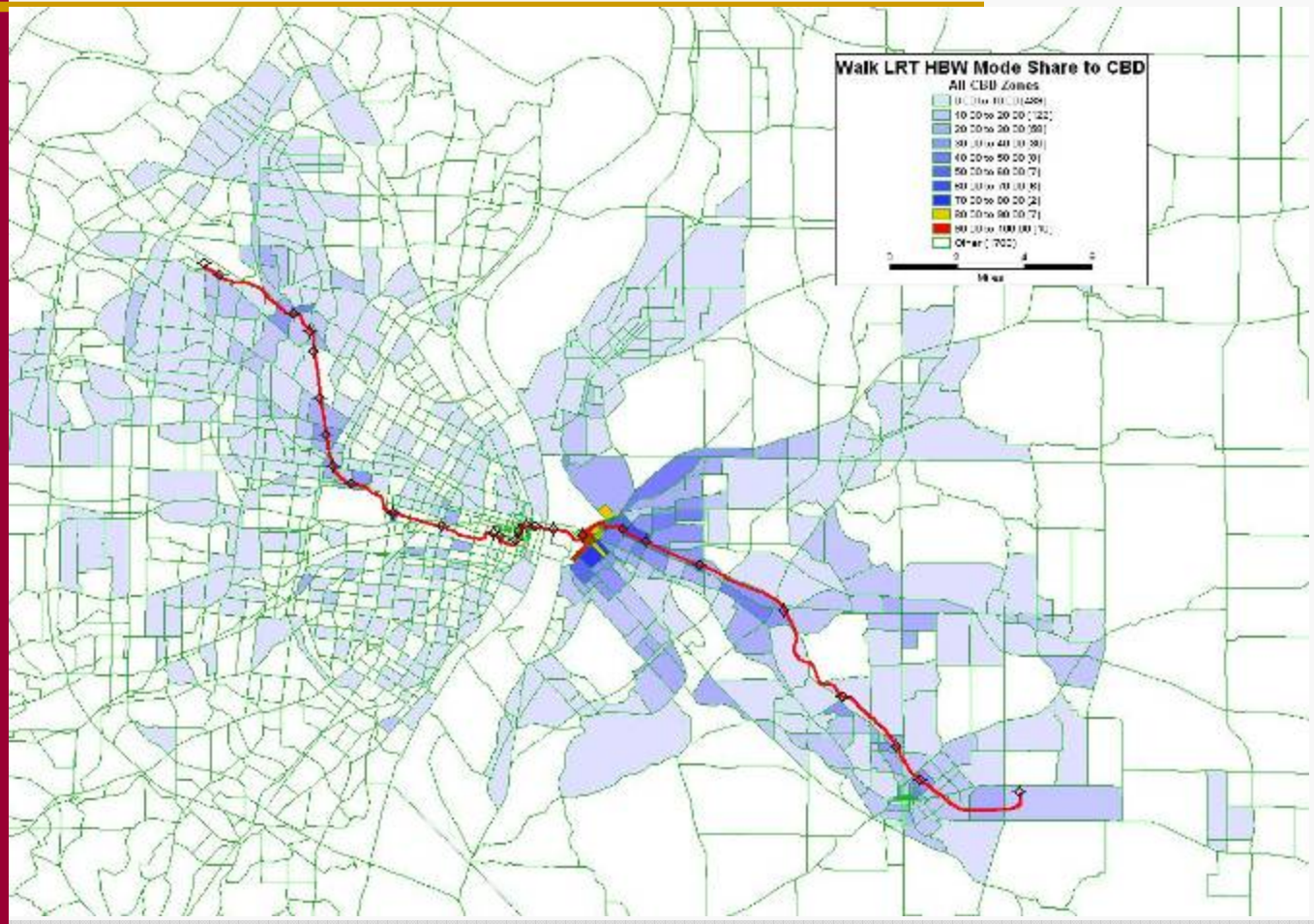
Other Constants

- HBO Drive-Transit constant=+7.5
  (Mkt Share 16% of all HBO transit)
- HBO Transit constant =-11.9
  (Mkt Share 0.8% of all HBO trips)

Walk-Rail Mode Shares to CBD



HBW Walk-LRT Shares to CBD



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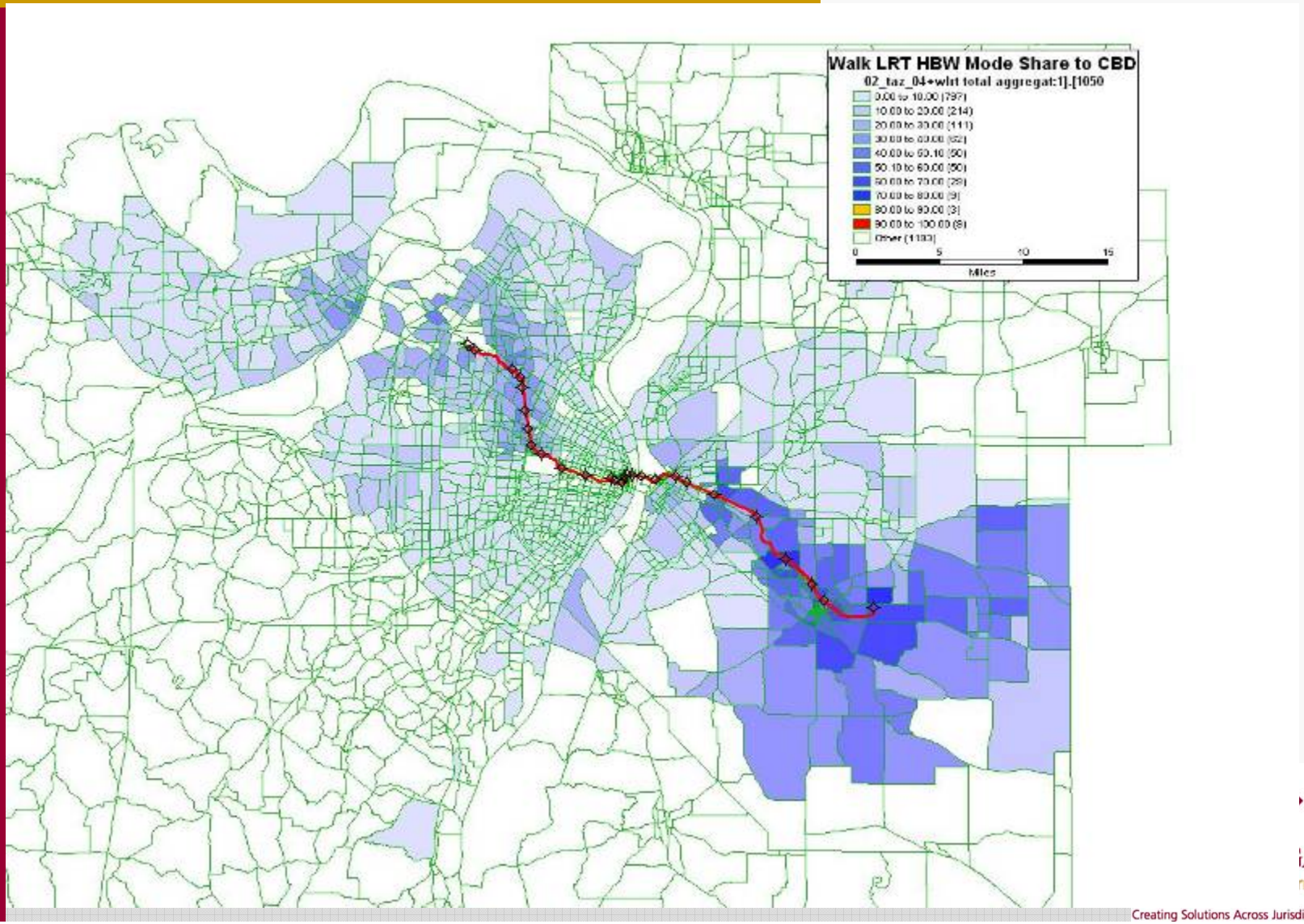
HBW Drive-LRT Shares to CBD



Trip Generation-Steve Ruegg

- Tables that show the production and attraction rates for each purpose (or tour), and comparisons against info from other regions.
- Identify total regional distribution of trips by purpose and market segment.
- Under reporting
- Trip Purposes and Market Segmentation-**avg trip rate and compare**
- Asserted models (Truck, University, Airports)
- Special location (malls)
- Externals

Trip Rates by Purpose

	per person	per hhld	per worker
WHBW	0.586	1.488	1.219
WHBO	0.157	0.399	0.327
WNHB	0.239	0.608	0.498
AWNHB	0.167	0.424	0.347
NWHBO	0.682	1.732	1.419
HBSHOP	0.702	1.782	1.460
NWNHB	0.554	1.408	1.153
HBK12	0.373	0.948	0.777
Work tour	0.983	2.496	2.045
At-Work tour	0.167	0.424	0.347
NW-tour	2.311	5.870	4.809
Chauffer	0.196	0.498	0.408
total	3.657	9.287	7.609

Non-response Rate

- +11% overall
- Applied to NHB and HBO purposes
- Based on GPS sample

Asserted Models

- Airport Trips – Mpls/St. Paul
  - Used split between hbo,wnhb,nwnhb
- College/Univ
  - Used NC State Data for resident and commuter generation
- Truck – Used Tampa model

Mall attractors

- Mall indicator modified trip attractions for HBSHOP trips to regional mall zones

External Trips

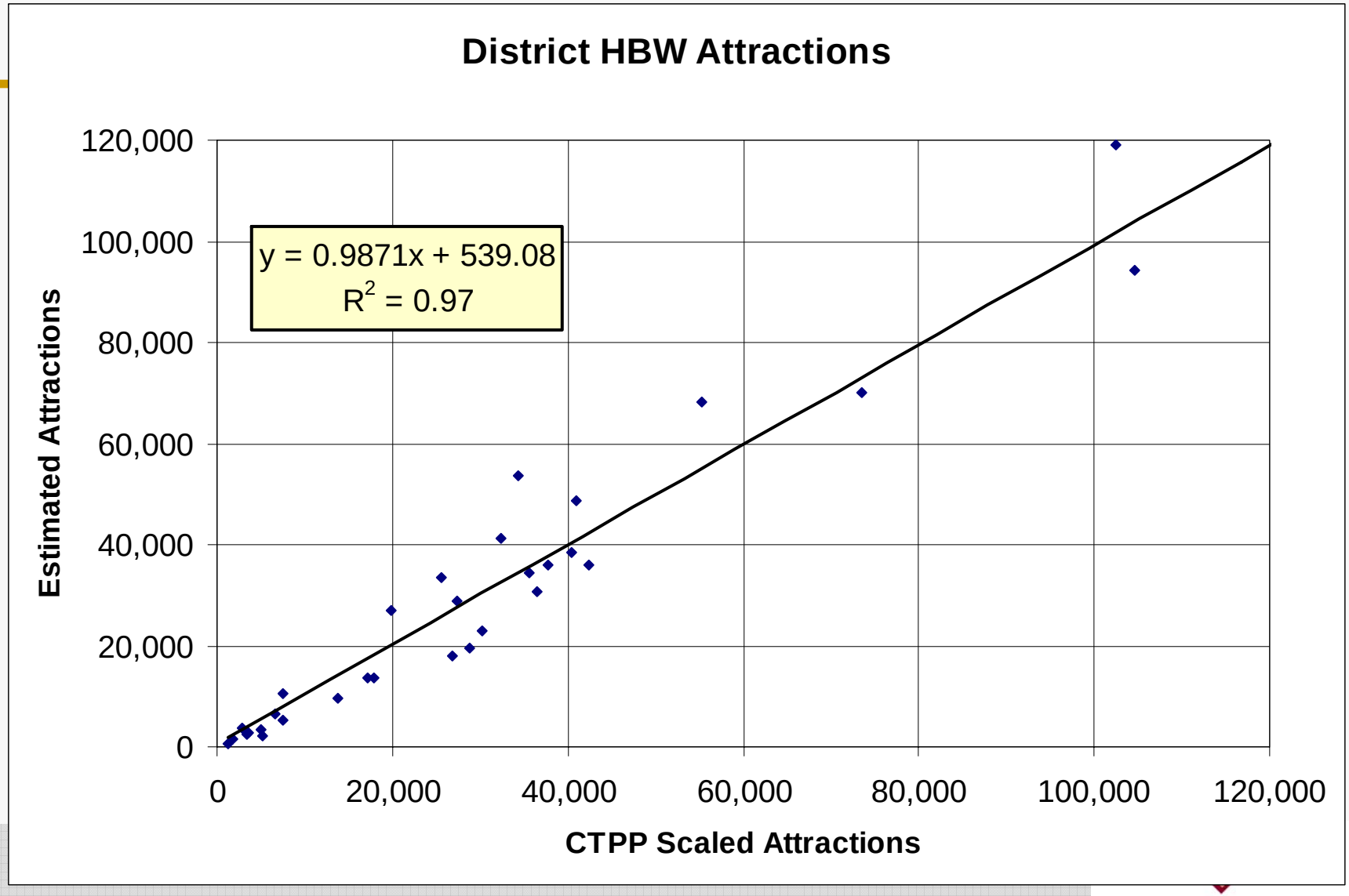
- Based on external vehicle volumes
- Uses fixed shares for truck, through, work and non-work trips
- P/A based on home location

NW-NHB CBD Attractions

- Initially overestimated by factor of 20
- Adjusted for CBD attractions

Trip Distribution-Steve Ruegg

- Sample zone selection
- Show how the Generation-calculated attractions in the 2,500 zones compares to what was generated from the singly-constrained distribution, aggregated to the District level, and provide the purpose-specific information in a table (with ratios for Distribution-based attractions/Generation-based attractions).
- nw-nhb attraction rate alteration
- **K factors application**



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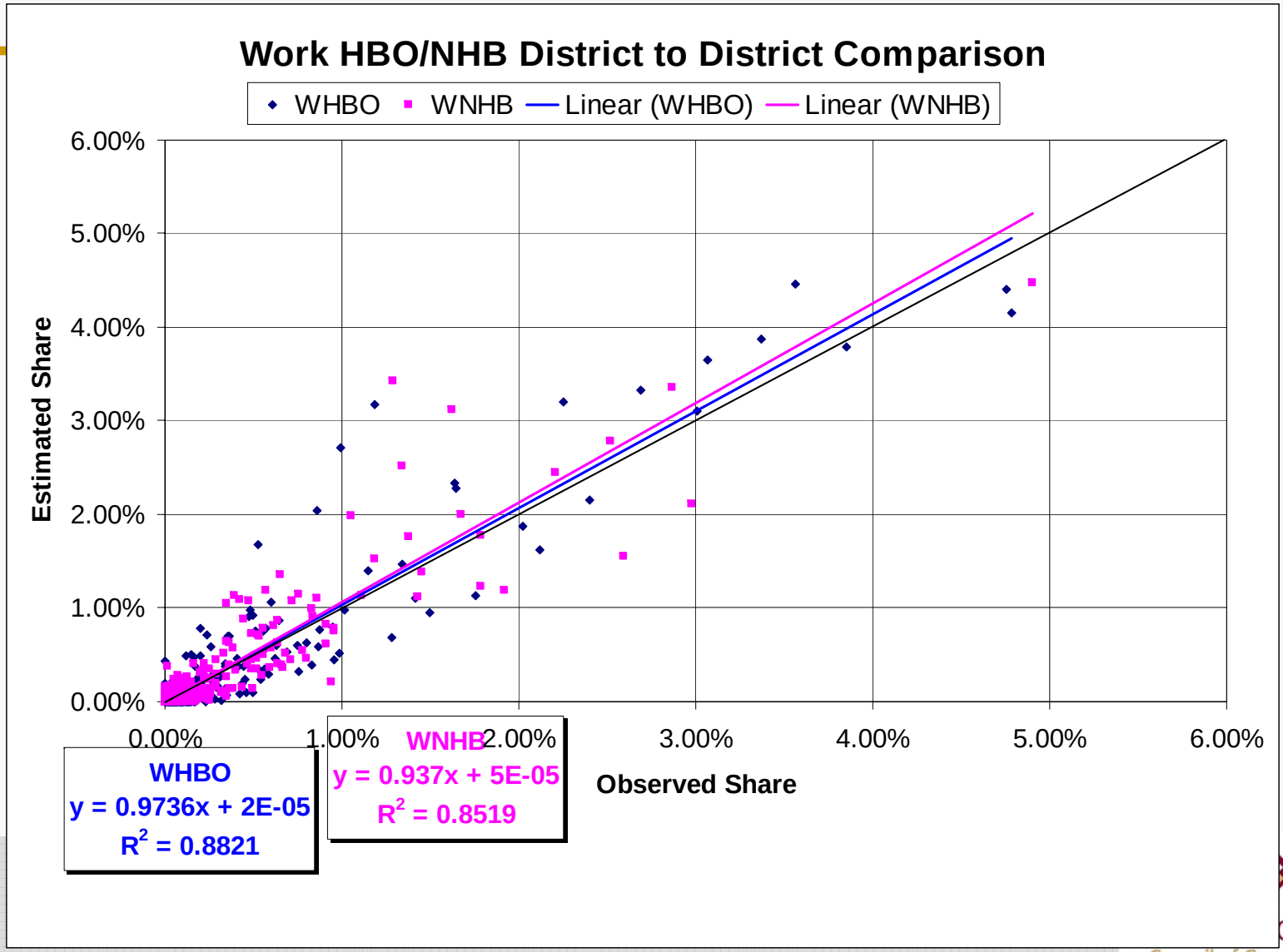
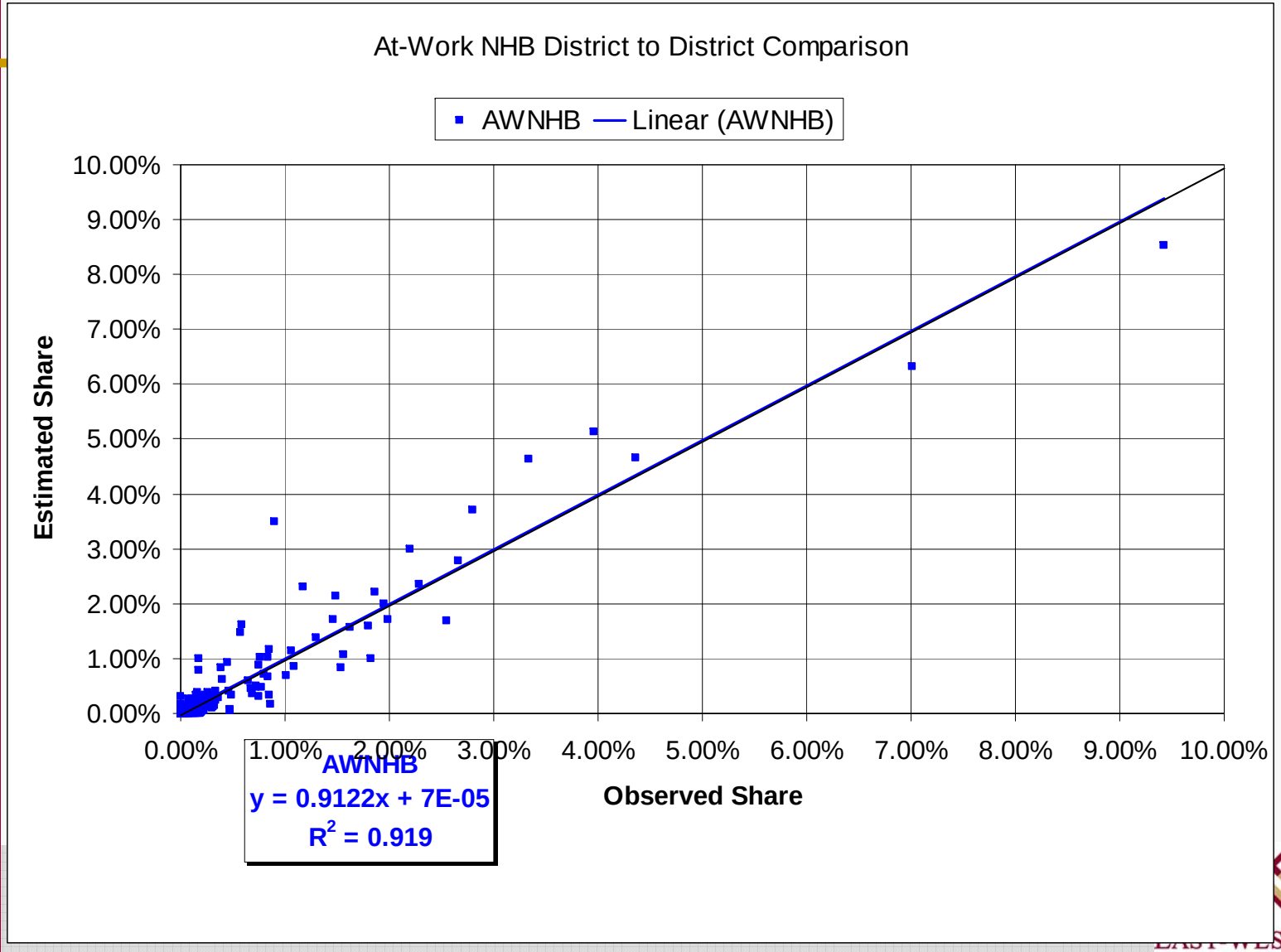

Work HBO/NHB District to District Comparison
WHBO
WNHB
Linear (WHBO)
Linear (WNHB)
Estimated Share
Observed Share
0.00%
1.00%
2.00%
3.00%
4.00%
5.00%
6.00%
WHBO
y = 0.9736x + 2E-05
R2 = 0.8821
WNHB
y = 0.937x + 5E-05
R2 = 0.8519



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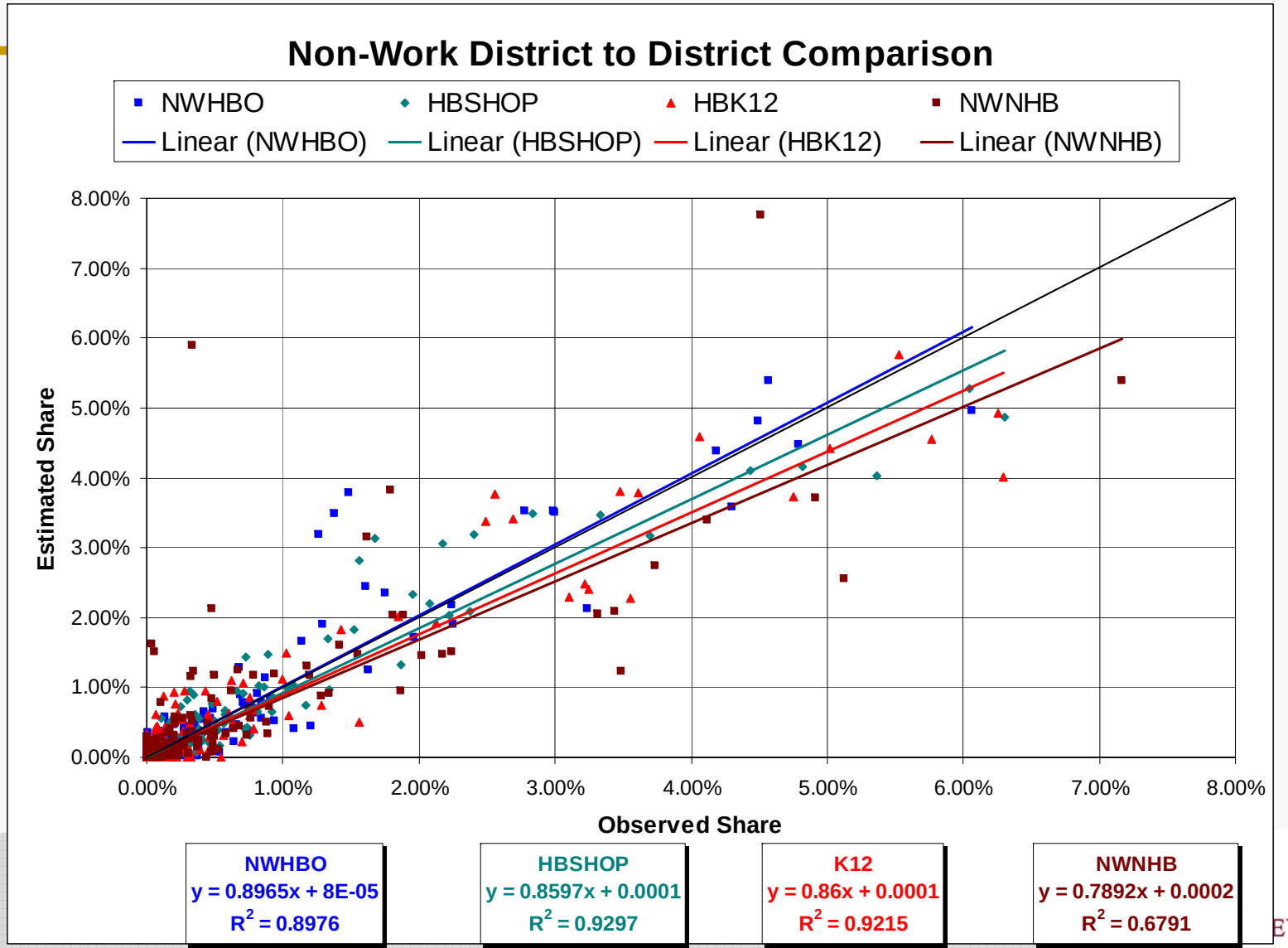

Non-Work District to District Comparison
NWHBO
HBSHOP
HBK12
NWNHB
Linear (NWHBO)
Linear (HBSHOP)
Linear (HBK12)
Linear (NWNHB)
Estimated Share
Observed Share
0.00%
1.00%
2.00%
3.00%
4.00%
5.00%
6.00%
7.00%
8.00%
NWHBO
y = 0.8965x + 8E-05
R2 = 0.8976
HBSHOP
y = 0.8597x + 0.0001
R2 = 0.9297
K12
y = 0.86x + 0.0001
R2 = 0.9215
NWNHB
y = 0.7892x + 0.0002
R2 = 0.6791

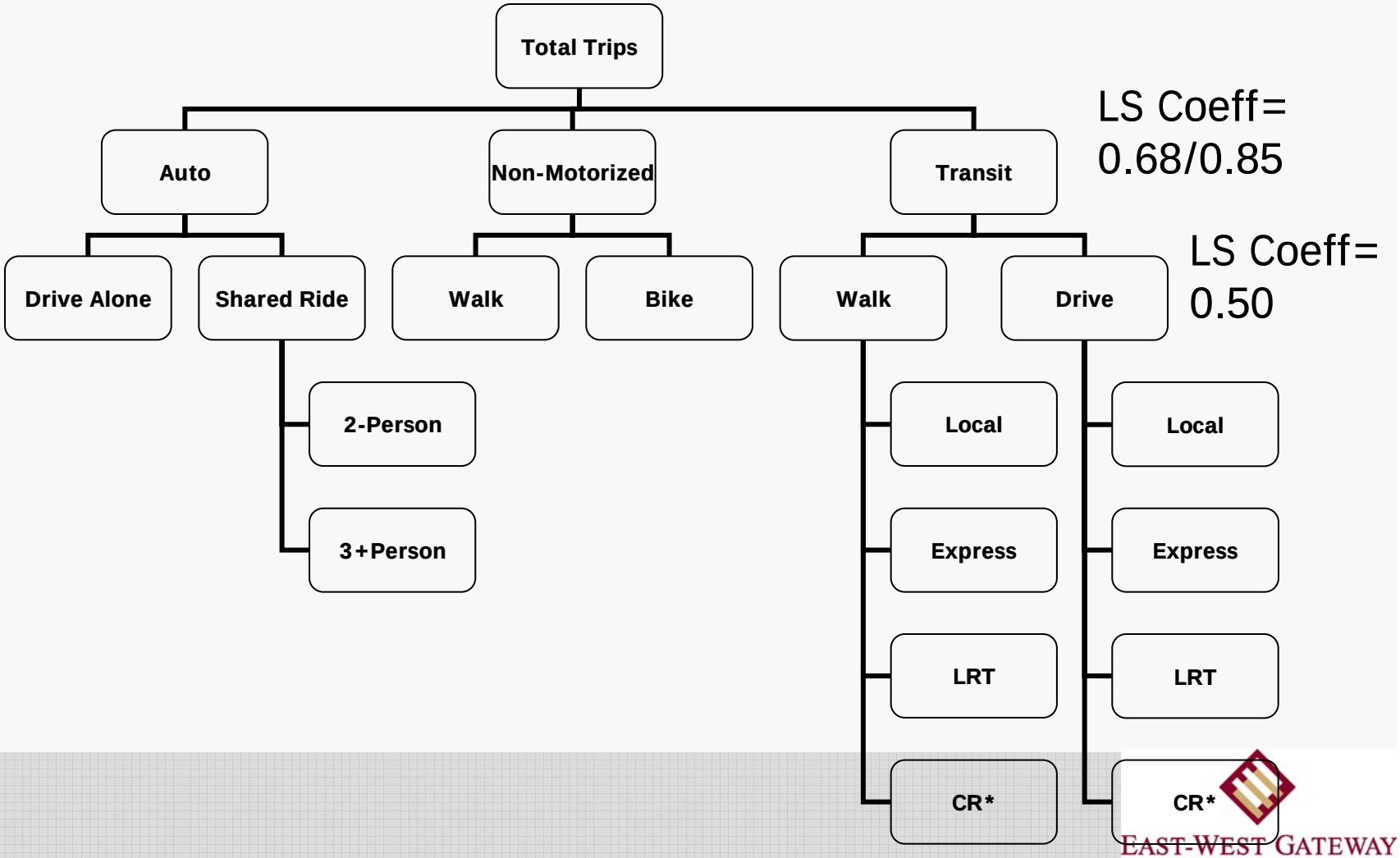
K-Factors

- For attraction Area-Types
  - Urban, Core, CBD, OBD
- Intra-County
- Intra-Zone
- Inter-State

Mode Choice--Steve Ruegg

- Show the nesting structures and the coefficients for each market segment, and identify how the "relative weights" of the MC coefficients compare to the skimming weighs.
- logsums factors
- Coefficients/FTA Standards
- Have a table that shows the total person trips for each market segment, by mode; as well as a column that shows the regional percent transit share

Mode Choice Model Structure



MC and Path-Building Weights

Measure	Path-building	MC
Initial Wait Time	2.0	2.5-2.6
Xfer Wait	3.0	2.0-2.6
Walk Time	2.0	2.5-4.0

Model Coefficients

	HBW	HBO	NHB
IVT	-0.025	-0.0150	-0.0150
Initial Wait	-0.0625	-0.040	-0.040
Long Wait	-0.025	-0.030	-0.040
Xfer Wait	-0.050	-0.040	-0.040
Walk Access	-0.0625	-0.060	-0.060
Cost ($)		-0.2150	-0.2050
Cost-Low	-0.5		
Cost-Med	-0.36		
Cost-High	-0.19		

HBW Modal Trip Shares

	HBW		
	Trips	Share	Est Share
DA	1,204,000	82.3%	81.5%
Shared Ride	180,000	12.3%	12.3%
Non-Motorized	31,000	2.1%	1.8%
Local Bus	34,000	2.3%	3.2%
Express Bus	2,000	0.1%	0.4%
MetroLink	12,000	0.8%	1.1%
Total	1,463,000	100.0%	100.0%

HBO Mode Shares

	HBO		
	Trips	Share	Est Share
DA	1,755,000	45.4%	46.7%
Shared Ride	1,849,000	47.9%	47.8%
Non-Motorized	228,000	5.9%	4.6%
Local Bus	23,000	0.6%	0.7%
Express Bus	100	<0.1%	<0.1%
MetroLink	8,000	0.2%	0.3%
Total	3,862,000	100.0%	100.0%

NHB Mode Shares

	NHB		
	Trips	Share	Est Share
DA	1,336,000	55.5%	57.8%
Shared Ride	913,000	37.9%	36.4%
Non-Motorized	140,000	5.8%	4.8%
Local Bus	13,000	0.5%	0.6%
Express Bus	100	<0.1%	<0.1%
MetroLink	5,000	0.2%	0.3%
Total	2,408,000	100.0%	100.0%

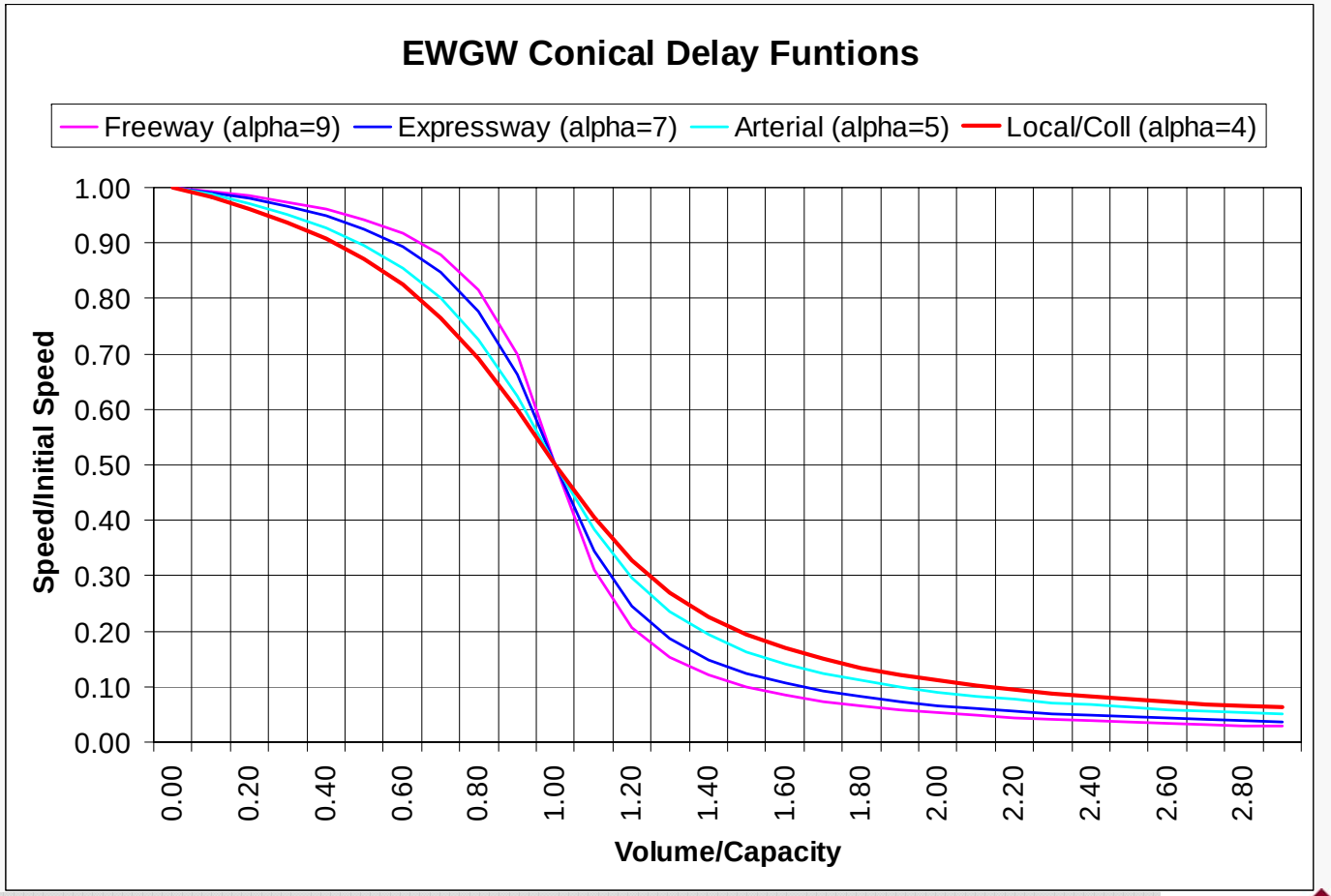
Feedback Loop

- Feedback criteria
- Based on D to D trip table and link times, compared to prev iteration
  - RMSE <10%
  - Or >90% of links/cells vary by <10%
- Current default to 2 feedback iterations

Assignment-Steve Ruegg

- Show the VDFs in graph format
- Identify the vehicle classes used
- Costs
- Moving from purposes to TOD
- Time of the day, periods and peak hour factors
- Convergence and Convergence Criteria for assignment, show how and why—how stable things have gotten and why we choose 19 iterations. There was a graph that showed the VMT and VDT fluctuation between iterations
- Counts and HMPS

VDF for Hwy Assignments



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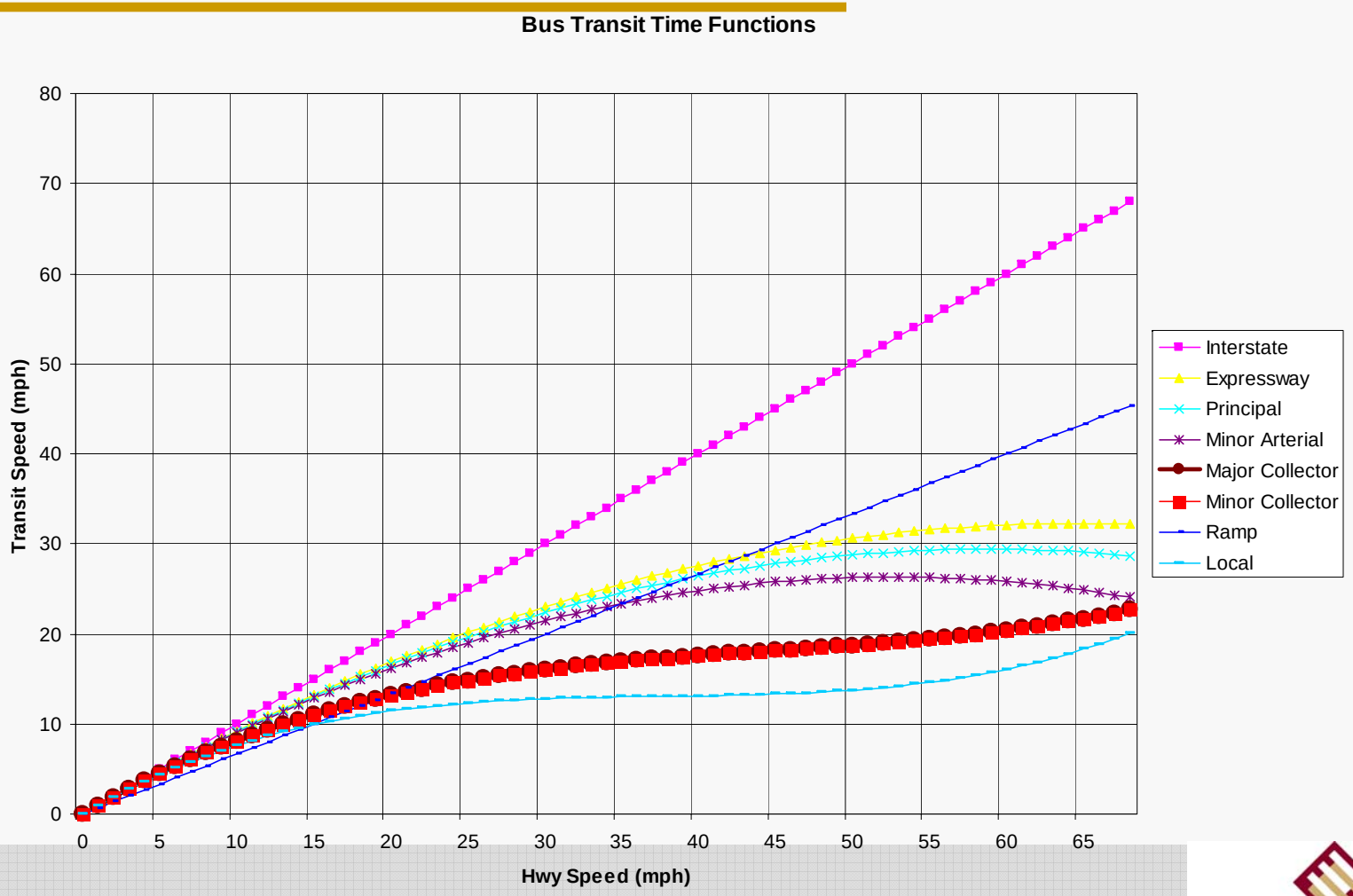
Bus Speed Functions



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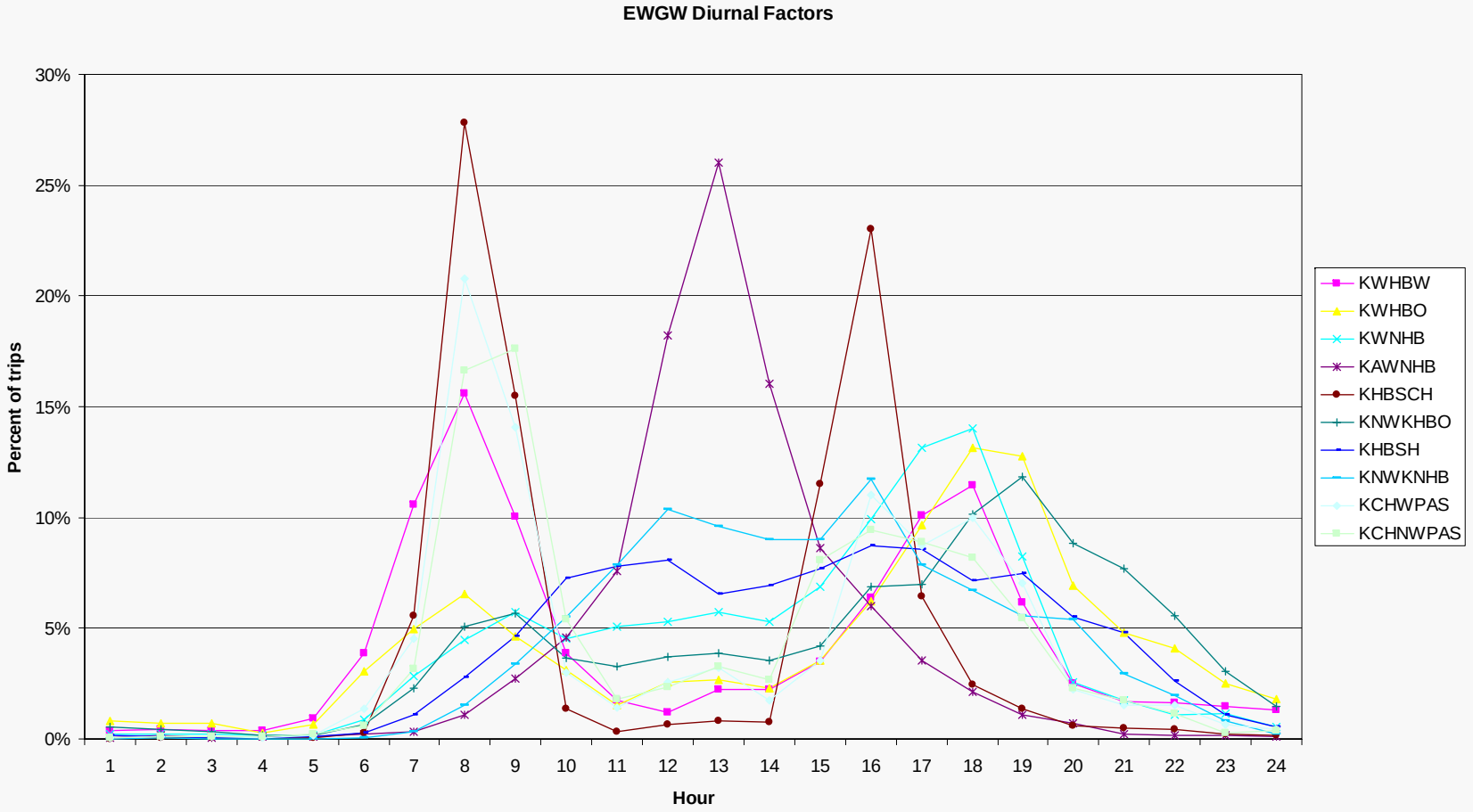
Vehicle Classes

- SOV
- HOV (user-defined, default 2+)
- Truck

Diurnal Factors



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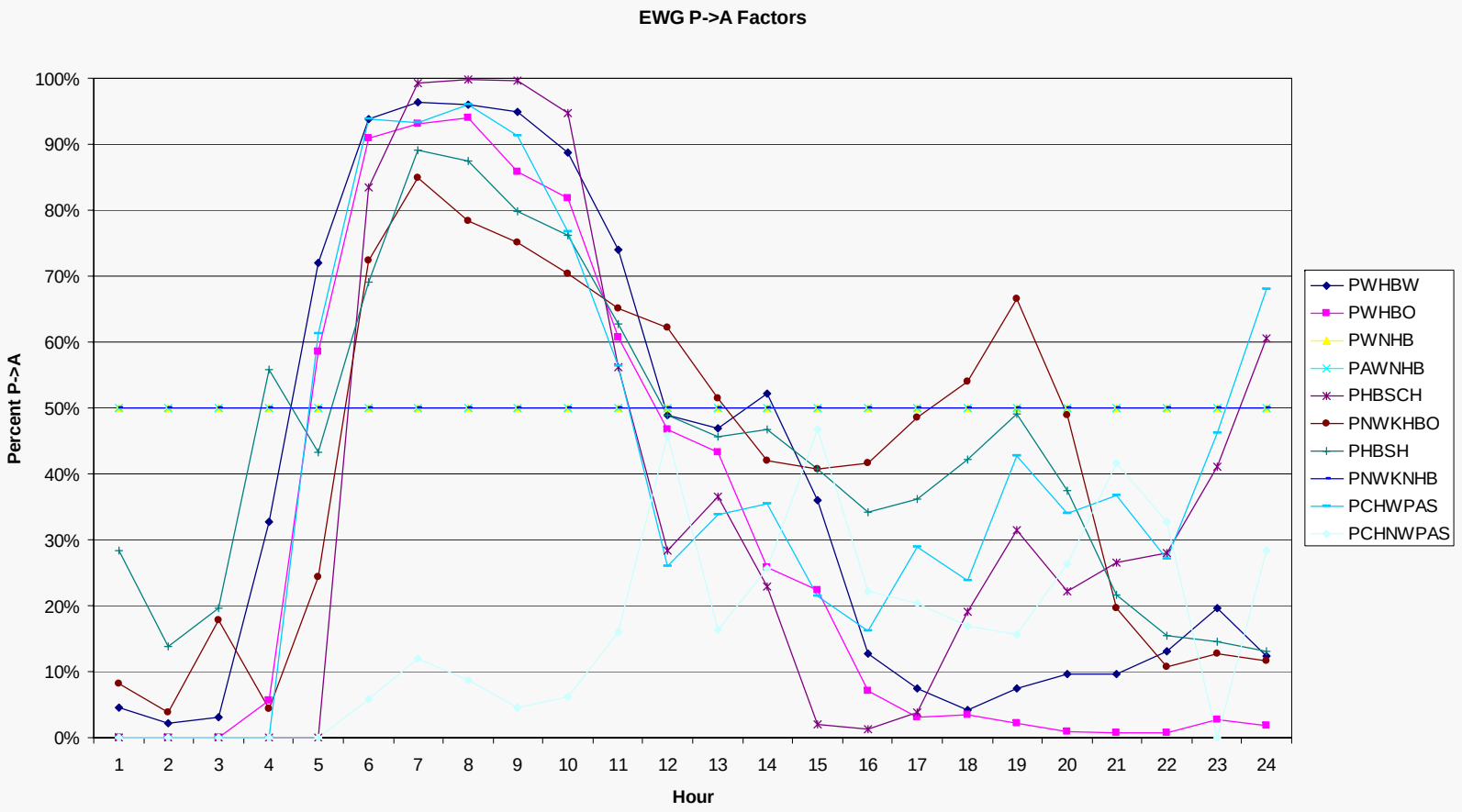
P->A factors



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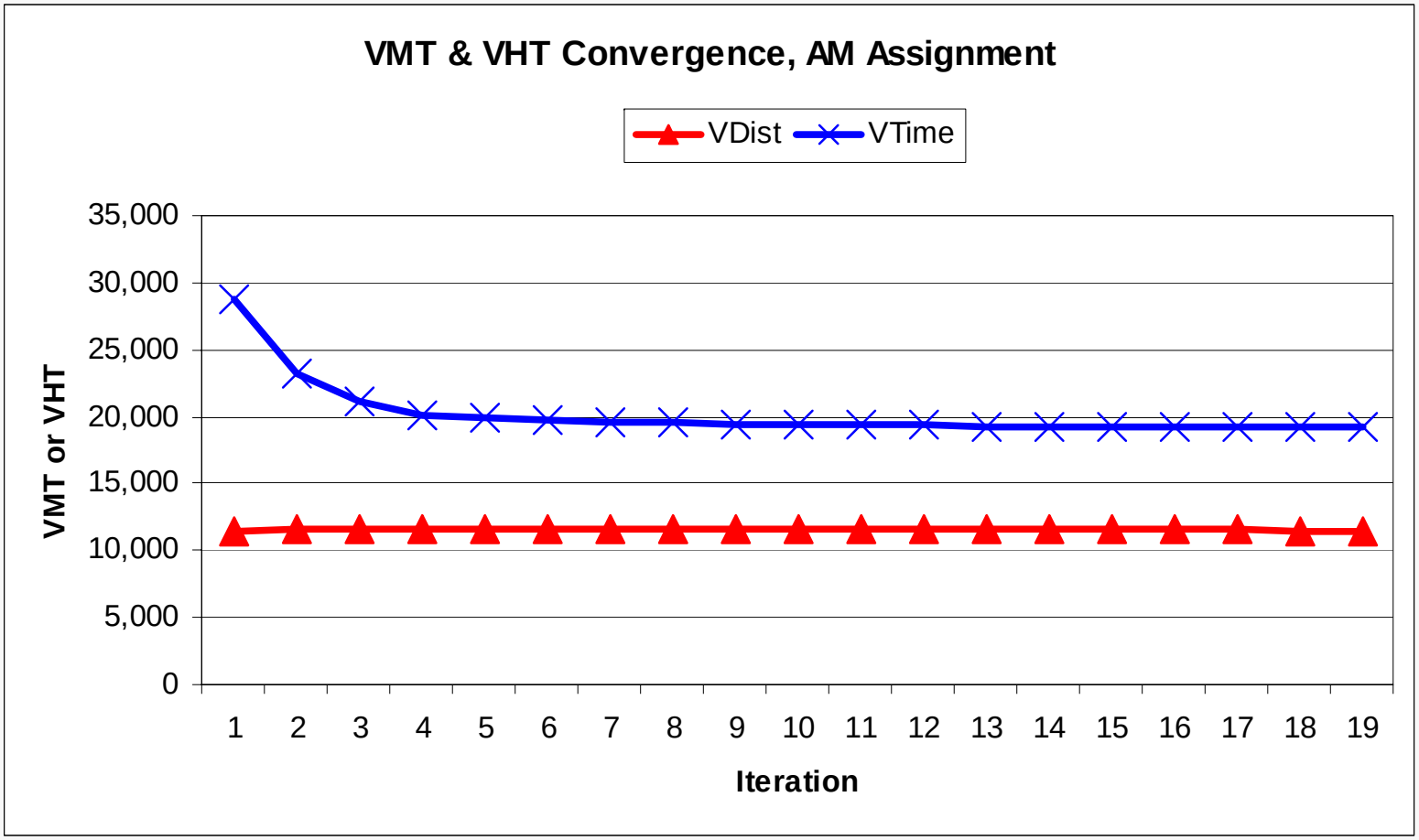
Period Definitions

- AM Peak 6am-9am 42.3% in highest hr
- MD 9am-2pm 22.4% in highest hr
- PM Peak 2pm-7pm, 23.7% in highest hr
- NT 7pm-6am 27.3% in highes hr

Assignment Convergence



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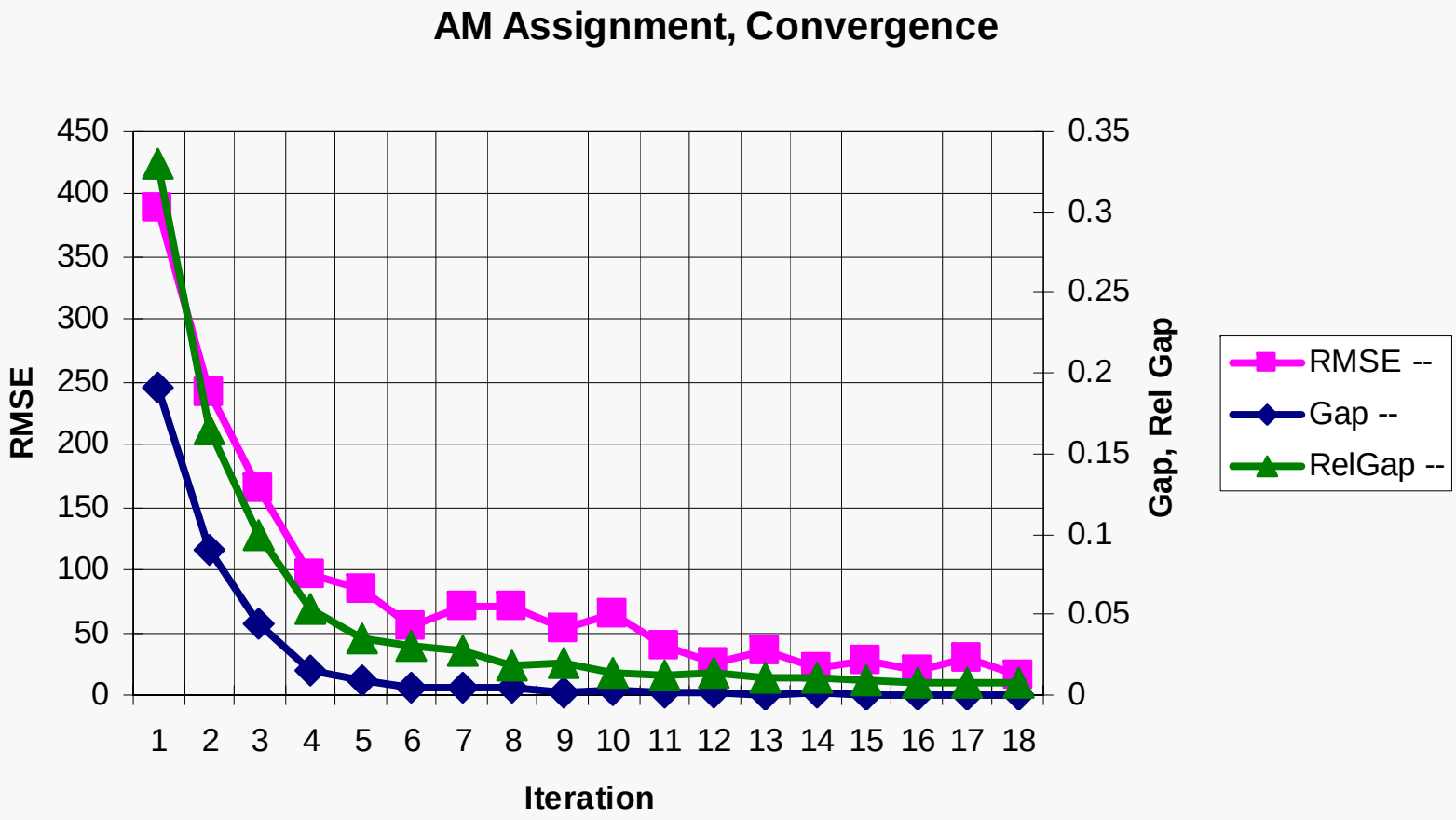
Assignment Convergence



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Questions

Computation Time

Type	# of Computers	Process	Time/Iteration (hr:min:sec)
Intra	1	Mode Choice/Destination Choice-Calibration Run	24:00:00
Intra	3	Mode Choice/Destination Choice-Calibration Run	08:26:50
Intra	6	Mode Choice/Destination Choice-Calibration Run	07:39:40
Intra	4	Convert Trip tables from MC/DC to Hourly	00:40:30
Intra	6	Convert Trip tables from MC/DC to Hourly	00:31:05
Intra & Multistep	1	Assignment AM	02:15:00
Intra & Multistep	2	Assignment AM	01:10:03
Intra & Multistep	4	Assignment AM	00:53:36
Intra	1	Hourly to Period Trip Tables	00:07:01
Intra	5	Hourly to Period Trip Tables	00:08:10

Questions